UNIVERSITY OF ILLINOIS

Agricultural Experiment Station

SOIL REPORT No. 41

HENRY COUNTY SOILS

By R. S. SMITH, E. E. DeTURK, F. C. BAUER, and L. H. SMITH

URBANA, ILLINOIS, OCTOBER, 1928

The Soil Survey of Illinois was organized under the general supervision of Professor Cyril G. Hopkins, with Professor Jeremiah G. Mosier directly in charge of soil classification and mapping. After working in association on this undertaking for eighteen years, Professor Hopkins died and Professor Mosier followed two years later. The work of these two men enters so intimately into the whole project of the Illinois Soil Survey that it is impossible to disassociate their names from the individual county reports. Therefore recognition is hereby accorded Professors Hopkins and Mosier for their contribution to the work resulting in this publication.

INTRODUCTORY NOTE

It is a matter of common observation that soils vary tremendously in their productive power, depending upon their physical condition, their chemical composition, and their biological activities. For any comprehensive plan of soil improvement looking toward the permanent maintenance of our agricultural lands, a definite knowledge of the various existing kinds or types of soil is a first essential. It is the purpose of a soil survey to classify the various kinds of soil of a given area in such a manner as to permit definite characterization for description and for mapping. With the information that such a survey affords, every farmer or landowner of the surveyed area has at hand the basis for a rational system of improvement of his land. At the same time the Experiment Station is furnished an inventory of the soils of the state, upon which intelligently to base plans for those fundamental investigations so necessary for solving the problems of practical soil improvement.

This county soil report is one of a series reporting the results of the soil survey which, when completed, will cover the state of Illinois. Each county report is intended to be as nearly complete in itself as it is practicable to make it, even at the expense of some repetition. There is presented in the form of an Appendix a general discussion of the important principles of soil fertility, in order to help the farmer and landowner to understand the significance of the data furnished by the soil survey and to make intelligent application of the same in the maintenance and improvement of the land. In many cases it will be of advantage to study the Appendix in advance of the soil report proper.

Data from experiment fields representing the more extensive types of soil, and furnishing valuable information regarding effective practices in soil management, are embodied in the form of a Supplement. This Supplement should be referred to in connection with the descriptions of the respective soil types found in the body of the report.

While the authors must assume the responsibility for the presentation of this report, it should be understood that the material for the report represents the contribution of a considerable number of the present and former members of the Agronomy Department working in their respective lines of soil mapping, soil analysis, and experiment field investigation. In this connection special recognition is due Mr. O. I. Ellis, who, as leader of the field party, was in direct charge of the mapping.

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SUPPLEMENT

HENRY COUNTY SOILS

By R. S. SMITH, E. E. DeTURK, F. C. BAUER, and L. H. SMITH[1]

PHYSICAL GEOGRAPHY OF THE COUNTY

Henry county is situated in the northwestern part of Illinois, a little above the 41st parallel of latitude. Rock river forms its northwestern border for about twenty miles. It is 815 square miles in area, and about a third of it lies in the Green river basin.

The Weather Bureau records taken at Galva for the 31-year period 1895 to 1926 are used as representing the climatic conditions of the county. The greatest range in temperature for any one year during this period was 126 degrees in 1899 and again in 1916. The lowest temperature was 28° below zero in 1905, the highest 108° in 1901. The average date of the last killing frost in the spring is April 28; the earliest in the fall, October 13. The average length of the growing season is therefore about 168 days.

The average annual rainfall for the period 1895 to 1926 was 33.11 inches. The rainfall by months was as follows: January, 1.65 inches; February, 1.43; March, 2.71; April, 2.85; May, 4.11; June, 3.71; July, 3.84; August, 3.61; September, 3.89; October, 2.11; November, 1.79; December, 1.42.

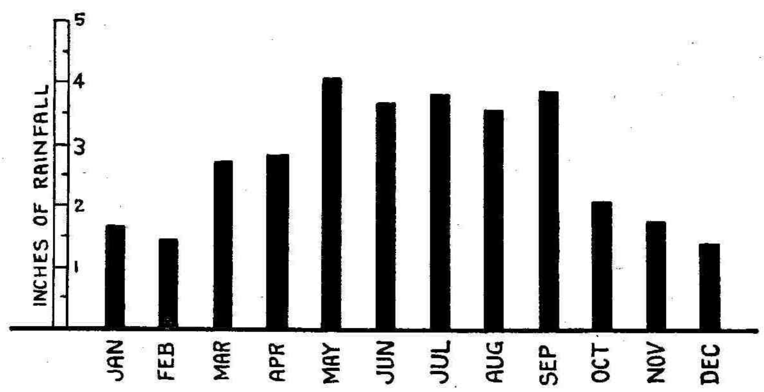

FIG. 1.—MONTHLY DISTRIBUTION OF RAINFALL IN HENRY COUNTY
The distribution of the rainfall thruout the year is on the whole favorable for the production of the crops commonly grown in Henry county.

AGRICULTURAL PRODUCTION

The diversified soil and topographic conditions in Henry county have resulted in diversified farming, with stock raising taking an important place in the agriculture of the county.

In 1920, according to the Fourteenth Census, there were 3,161 farms in Henry county, a decrease of about 5 percent in ten years. The following figures show the acreage and production of the principal crops grown in the county for the year 1919:

[1] R. S. Smith, in charge of soil survey mapping; E. E. DeTurk, in charge of soil analysis; F. C. Bauer, in charge of experiment fields; L. H. Smith, in charge of publications.

Crops	*Acreage*	*Production*	*Yield per acre*
Corn	146,430	6,587,017 bu.	44.9 bu.
Oats	75,295	2,449,223 bu.	32.5 bu.
Wheat	22,423	424,981 bu.	18.9 bu.
Timothy	10,763	14,926 tons	1.38 tons
Timothy and clover mixed	27,301	41,966 tons	1.54 tons
Clover	9,157	13,933 tons	1.52 tons
Alfalfa	1,440	3,960 tons	2.75 tons
Silage crops	6,887	59,037 tons	8.57 tons
Corn for forage	3,624	8,223 tons	2.27 tons

The total value of all crops for 1919 was estimated at $15,746,000. No figures are available showing the acreage used for pasture but the hilly and eroded portions are very generally devoted to this use.

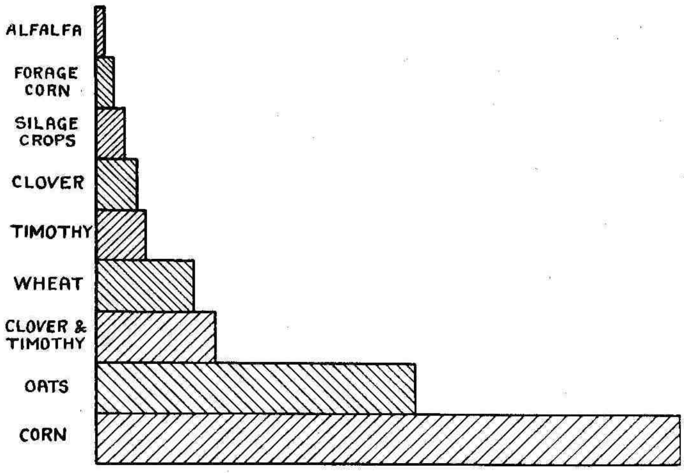

FIG. 2.—RELATIVE ACREAGE OF FIELD CROPS IN HENRY COUNTY

The diagram brings out the preponderance of land devoted to corn and oats. Legume crops might well occupy a larger proportion of the cultivated acreage. (From 1920 Census.)

The importance of the livestock industry in this county, particularly beef cattle and hogs, is shown by the following figures taken from this same Census:

Animals and Animal Products	*Number*	*Value*
Horses	22,155	$2,193,837
Mules	867	112,503
Beef cattle	55,637	3,593,766
Dairy cattle	14,750	1,025,301
Sheep	13,215	167,622
Swine	140,286	3,310,466
Chickens and other poultry	352,134	368,371
Chickens and eggs sold	......	550,815
Dairy products sold	......	525,664

The total value of livestock and livestock products as shown by these figures, was nearly $12,000,000 in 1919.

Fruit growing is not important in Henry county and commercial vegetable growing is limited to certain areas of peat, particularly the one four miles north and a mile and a half east of Annawan, where a large acreage of onions is grown more or less regularly.

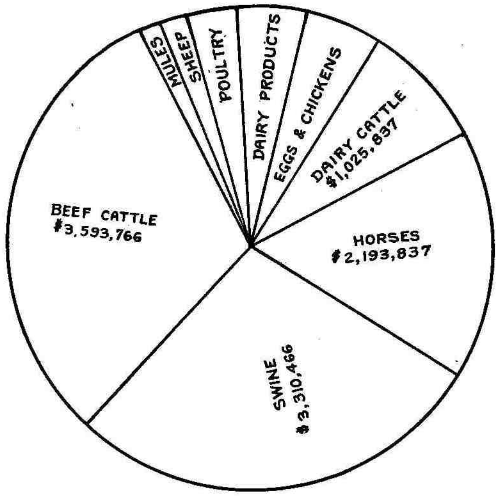

FIG. 3.—RELATIVE VALUES OF ANIMALS AND ANIMAL PRODUCTS

Cattle and swine production predominate in this county. (From 1920 Census.)

ORIGIN AND DEVELOPMENT OF SOILS

The soils in the upland portion of Henry county, for the most part south of Route 7, are derived from material deposited during glacial times, either directly by the ice sheets or by the wind. One of the most important periods in the geological history of the county, from the standpoint of soil formation, was the Glacial period, during and immediately following which the material that later formed the mineral portion of the soils was being deposited. At that time snow and ice accumulated in the region of Labrador and to the west of Hudson Bay to such an amount that the mass pushed outward from these centers, chiefly southward, until a point was reached where the ice melted as rapidly as it advanced. In moving across the country from the far north, the ice gathered up all sorts and sizes of material, including clay, silt, sand, gravel, boulders, and even immense masses of rock. Some of these materials were carried for hundreds of miles and rubbed against surface rocks and against each other until largely ground into powder. When the limit of advance of the ice sheet was reached, the rock material carried by the ice accumulated along the front of the glacier in a broad, undulating ridge or moraine. When the ice melted more rapidly than the glacier advanced, the terminus of the glacier receded, and the material was deposited somewhat irregularly over the area previously covered. The mixture of materials deposited by the glacier is known as boulder clay, till, glacial drift, or simply drift. The thickness of this deposit varies greatly; the average depth over the state of Illinois has been estimated as 115 feet.

The area now comprizing Henry county was covered by one of these ice sheets known as the Illinoisan glaciation, which partially leveled the region by rubbing down the hills and filling the valleys. A later glaciation, known as the Iowan, may have covered a small portion of the county south of Annawan. This

later ice sheet, however, played an important role in the formation of the soils of the county because the water from the melting ice carried large quantities of sediment and deposited it on the extensive bottom lands and terraces. Later much of this material in the form of fine sand and silt, known as loess, was blown on to the upland. In places this wind-blown material occurs as hills in very heavy deposits, while on the undulating and rolling plains it is deposited in thinner layers. This loessial deposit varies from 2 or 3 feet to 40 feet or more in thickness. The soils of this portion of the county are mainly derived from loess.

The soil material deposited during and following the great ice age has been subject to weathering thru the thousands of years since it was laid down. The character of the soils of the county is largely the result of the conditions under which they have been formed. The relatively level portions of the upland have a heavy, well-developed subsoil, while the subsoil of the rolling portions is much less compact and shows less distinct development. The lower areas have a deeper top soil than the higher areas and are usually less acid. The loess, when it was deposited, was highly calcareous, but its finely divided condition has allowed rapid leaching so that at the present time the soil of the undulating and rolling plains does not show effervescence with acid until a depth of 60 inches or more is reached.

PHYSIOGRAPHY AND DRAINAGE

Henry county presents considerable diversity in topography. The large terrace area varies from flat to undulating, with low hills where the wind has been active in drifting the sand. The upland is an undulating plain which has been cut into by the various streams. A hilly region just south of Geneseo and Atkinson has been formed by the piling up of wind-blown material from the terrace.

A large part of the drainage of the county is carried by Green river into Rock river and thence into the Mississippi. The southwestern part of the county is drained by Edwards river directly into the Mississippi. The drainage from a small area in the southeast corner of the county is carried off by West Fork of Spoon creek into Spoon river and thence into the Illinois river at Havana.

The altitudes of a few points in the county are as follows: Atkinson, 651 feet; Cambridge, 814; Galva, 850; Geneseo, 643; Kewanee, 854; Woodhull, 824.

SOIL GROUPS

The soils of Henry county are divided into four groups as follows:

Upland Prairie Soils, usually rich in organic matter. These areas originally were covered with wild prairie grasses, the partially decayed roots of which have been the chief source of organic matter. The upland prairie soils include some areas the soils of which have been modified somewhat by the growth of timber thru a relatively short period of time. It is not uncommon for such areas of varying width to occur between timber soils and prairie soils.

Upland Timber Soils, including those areas along stream courses over which forests grew for a long period of time. Timber soil contains less organic matter

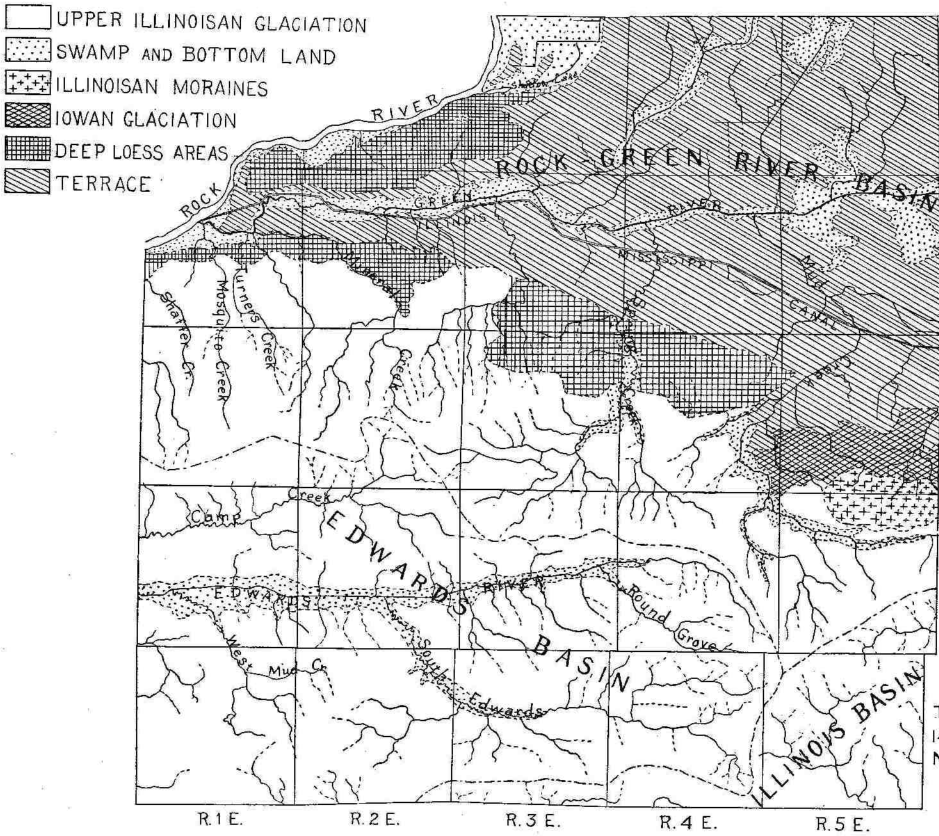

FIG. 4.—DRAINAGE MAP OF HENRY COUNTY SHOWING STREAM COURSES, GLACIATIONS, BOTTOM-LAND, TERRACE, AND DEEP-LOESS AREAS

than prairie soil because the large roots of dead trees and the surface accumulation of leaves, twigs, and fallen trees suffered almost complete decay or were burned by forest fires. The timber soils are divided into two groups, the undulating and the eroded.

Terrace Soils, formed by deposits from flooded streams overloaded with sediment. Finer deposits which were later made upon the coarser material constitutes the soil material. Large quantities of sand deposited and reworked by the wind form the sand dunes.

Swamp and Bottom-Land Soils, which include the flood plains along the streams and some poorly drained muck and peat areas.

Table 1 gives the list of soil types in Henry county, the area of each in square miles and in acres, and also the percentage of the total area. The accompanying map, shown in four sections, gives the location and boundary of each soil type which has been mapped in the county.

For explanations concerning the classification of soils and the interpretation of the map and tables, the reader is referred to the first part of the Appendix.

TABLE 1.—SOIL TYPES OF HENRY COUNTY, ILLINOIS

Soil type No.	Name of type	Area in square miles	Area in acres	Percent of total area
	Upland Prairie Soils (200, 500, 700, 800)			
226, 526, 726	Brown Silt Loam[1]	373.60	239 104	45.82
520, 720	Black Clay Loam	.95	608	.12
841	Brown Fine Sandy Silt Loam	29.62	18 957	3.63
560, 760	Brown Sandy Loam	1.28	819	.15
528, 728	Brown-Gray Silt Loam On Tight Clay	1.00	640	.13
781	Dune Sand	1.13	723	.14
		407.58	260 851	49.99
	Upland Timber Soils (200, 500, 700, 800)			
234, 534, 734	Yellow-Gray Silt Loam	22.01	14 086	2.70
235, 535, 735	Yellow Silt Loam	59.63	38 163	7.32
844	Yellow-Gray Fine Sandy Silt Loam	10.87	6 957	1.34
845	Yellow Fine Sandy Silt Loam	11.93	7 635	1.46
		104.44	66 841	12.82
	Terrace Soils (1500)			
1526	Brown Silt Loam	82.83	53 011	10.16
1520	Black Clay Loam	15.25	9 760	1.88
1517	Black Clay	12.78	8 179	1.57
1525	Black Silt Loam	17.55	11 232	2.13
1561	Black Sandy Loam	6.13	3 923	.75
1571	Brown Fine Sandy Loam	1.11	710	.14
1560	Brown Sandy Loam	29.58	18 931	3.63
1528	Brown-Gray Silt Loam On Tight Clay	7.15	4 576	.88
1568	Brown-Gray Sandy Loam On Tight Clay	.63	403	.08
1581	Dune Sand	18.41	11 782	2.26
		191.42	122 507	23.48
	Swamp and Bottom-Land Soils (1400)			
1426	Deep Brown Silt Loam	45.65	29 216	5.60
1420	Black Clay Loam	1.22	781	.15
1454	Mixed Loam	42.69	27 321	5.22
1450	Black Mixed Loam	7.98	5 107	.98
1463.8	Black Mixed Sandy Loam	2.27	1 453	.28
1463.7	Brown Mixed Sandy Loam	1.33	851	.16
1460	Brown Sandy Loam	1.42	909	.17
1402	Medium Peat On Clay	.19	122	.02
1401	Deep Peat	7.47	4 780	.92
		110.22	70 540	13.50
	Water	1.58	1 011	.19
	Swamp	.18	115	.02
		1.76	1 126	.21
	Total	815.42	521 865	100.00

[1]Including associated types described in the text but not differentiated on the map.

INVOICE OF THE ELEMENTS OF PLANT FOOD IN HENRY COUNTY SOILS[1]

Three Depths Represented by Soil Samples

In the Illinois soil survey each soil type is sampled in the manner described below and subjected to chemical analysis in order to obtain a knowledge of its important plant-food elements. Samples are taken, usually in sets of three, to represent different strata in the top 40 inches of soil, namely:

1. An upper stratum extending from the surface to a depth of 6⅔ inches. This stratum over the surface of an acre of the common kinds of soil, includes approximately 2 million pounds of dry soil.
2. A middle stratum extending from 6⅔ to 20 inches and including approximately 4 million pounds of dry soil to the acre.
3. A lower stratum extending from 20 to 40 inches and including approximately 6 million pounds of dry soil to the acre.

By this system of sampling we have represented separately three zones for plant feeding. It is with the upper, or surface layer, that the following discussion is mostly concerned, for it includes the soil that is ordinarily turned with the plow, and is the part with which the farm manure, limestone, phosphate, or other fertilizing material is incorporated. Furthermore it is the only stratum which can be greatly changed in composition as a result of adding fertilizers.

For convenience in making application of the chemical analyses, the results presented in Tables 2, 3, and 4 are given in terms of pounds per acre. It is a simple matter to convert these figures to a percentage basis in case one desires to consider the information in that form. In comparing the composition of the different strata, it must be kept in mind that it is based on different quantities of soil, as indicated above. In order to show the comparative concentration of the various constituents in the different strata, the figures for the middle and lower strata must therefore be divided by two and three respectively.

Wide Range in Organic Matter and Nitrogen

It can readily be seen from Table 2 that there is a wide variation among the different soil types of Henry county with respect to their content of the different plant-food elements in the upper 6⅔ inches of soil. There appears to be but little relationship among these variations except with respect to organic carbon and nitrogen, the quantities of which run parallel from type to type tho the organic-carbon content is usually 10 to 12 times as great as the nitrogen. This relationship between organic carbon and nitrogen is explained by the well-established fact that all soil organic matter (of which organic carbon is the measure) contains nitrogen, and that most of the soil nitrogen—usually 98 percent or more—is present in a state of organic combination, that is, as a part of the organic matter. This relationship is also maintained in the middle and lower sampling strata.

The range in soil content of organic matter and nitrogen is very wide. The upland prairie soils are for the most part relatively high in these constituents.

[1] In the chemical study of the Henry county soils, some samples representing the respective types were collected in bordering counties.

The upland timber soils are generally fairly low. The upland timber soils range from 13,650 pounds of organic carbon an acre in Yellow Fine Sandy Silt Loam up to 30,940 pounds in Yellow-Gray Silt Loam, with an average of 22,090 pounds. The upland prairie soils, exclusive of Dune Sand, range from 31,150 to 88,650 pounds, and average 55,380 pounds, or more than twice the amount found in the former group. Dune Sand is omitted from the average for upland prairie soils as given above. This, as is usually the case with very sandy soils, is very deficient in organic matter and nitrogen, the organic carbon amounting to only 12,420 pounds an acre in the surface stratum. The porous, open character of these soils permits the rapid oxidation of organic matter, so that it disappears from the soil much more rapidly than from the heavier types. Dune Sand is in fact but little more than the skeleton of a soil and cannot readily be brought up to, and maintained in, a state of productiveness without first incorporating active organic materials in it and continuing with frequent subsequent additions. The soil is usually acid and hence limestone and legume green manures constitute the first and most important steps in converting it into a productive soil.

The soils richest in organic matter and nitrogen are found in the terrace and bottom-land groups. Black Silt Loam contains the largest amount of organic carbon of any soil in the county except Deep Peat and Medium Peat, which are composed mainly of organic matter. The organic carbon of Black Silt Loam amounts to 188,480 pounds an acre, with a corresponding nitrogen content of 18,350 pounds. While such soils as this will withstand more abuse by the practice of continuous cropping than most soils, and are not so greatly in need of additions of organic carbon, yet the use of manure and the systematic growing of legumes for pasture and plowing down serve to renew the active organic material in the soil in a way which is reflected in increases of crop yields.

Phosphorus Content of Light-Colored Soils Relatively Low

With regard to total phosphorus, the upland timber soils on the whole are found to be the most deficient, while the bottom-land soils rank highest in this element. As is usually the case, Black Silt Loam and Black Clay Loam are outstanding types with respect to high phosphorus content. Black Silt Loam is high not only in phosphorus but in all other elements except potassium. This type, however, is not very extensive, occupying only 17.55 square miles or about 2 percent of the area of the county. As in the case of organic matter and nitrogen, Dune Sand resembles the upland timber soils in its low phosphorus content.

Phosphorus, in contrast with certain other elements, is not removed from the soil by leaching. It is converted by growing plants into organic forms and tends to accumulate in the surface soil in these forms in plant residues at the expense of the underlying strata. Thus a portion of the soil phosphorus is also associated with soil organic matter. The second stratum ($6\frac{2}{3}$ to 20 inches) furnishes much of the phosphorus thus moved upward, altho obviously the lower stratum has also contributed. Consequently the surface soil generally contains a larger proportionate amount of phosphorus than the middle stratum and, in the majority of cases, more than the lower stratum.

Sulphur Generally Well Supplied

While not so closely associated with each other as organic matter and nitrogen, there is some degree of correlation between sulfur, and organic carbon. This is because a considerable tho varying proportion of the sulfur in the soil exists in the organic form, that is, as a constituent of the organic matter. Most of the Henry county soils are fairly well supplied with sulfur, the sandy types being the lowest. It ranges in the surface soil from a minimum of 260 pounds an acre in the upland Dune Sand to 2,800 pounds in Black Silt Loam, Terrace. These analyses show a sulfur content ranging for the most part from half to three-fourths as high as the phosphorus content, averaging approximately two-thirds as high. The peaty soils and the Black Silt Loam, all very high in organic matter, contain large quantities of sulfur, varying from 2,120 to 2,800 pounds an acre in the surface stratum, and in these the sulfur content is considerably greater than the phosphorus content.

The sulfur content decreases with increasing depth in nearly all cases, as may be seen from a comparison of the figures in Tables 2, 3, and 4. This is to be expected since, as stated above, a portion of the sulfur exists in combination with the organic matter of the soil, and not only is the organic matter more abundant in the upper stratum, but also the organic forms of sulfur are held more tenaciously against the leaching action of ground water than are the inorganic forms.

The sulfur available to crops, however, is affected not only by the soil supply, but also by that brought down from the atmosphere by rain. Sulfur dioxid escapes into the air in the gaseous products from the burning of all kinds of fuel, particularly coal. The gaseous sulfur dioxid is soluble in water and consequently is dissolved out of the air by rain and brought to the earth. In regions of large coal consumption the amount of sulfur thus added to the soil is relatively large. At Urbana during the eight-year period from 1917 to 1924 there has been added to the soil by the rainfall an average of 3.5 pounds of sulfur an acre a month. Similar observations have been made in other localities for shorter periods. The precipitation at the various points in the state in a single month has varied from a minimum of three-fourth of a pound to more than 10 pounds an acre.

These figures afford some idea of the amount of sulfur added by rain and also of the wide variations under different conditions. On the whole the facts would indicate that the sulfur added from the atmosphere supplements adequately that contained in the soil, so that apparently there is little need for sulfur fertilizers in Henry county. In order to determine definitely the response of crops to applications of sulfur fertilizers, experiments with gypsum have been started on a number of the Illinois experiment fields.

Potassium Deficient in Peaty and Sandy Types

Potassium is deficient in Deep Peat and in Medium Peat, as is usually the case with these types, the total amounts in the upper 6⅔ inches of soil being 6,950 and 6,420 pounds an acre respectively. The sandy types of Henry county contain on the average only about two-thirds as much potassium as the mineral soils of finer texture. In addition to the handicap of smaller total quantities of

this element, sandy soils carry a considerable proportion of their potassium content in the coarse sand grains. The relatively smaller total surface exposed in the case of these coarser soil particles greatly reduces the rate at which potassium is dissolved, thus lowering its availability. This deficiency of available potassium in the sandy soils may be offset, at least in part, by the greater facility with which crop roots can penetrate soils of that character as compared with the heavier types.

The other soil types of Henry county are normal in their content of potassium. Potassium exhibits little difference in percentage in the three sampling layers.

Calcium and Magnesium Vary Widely Within the Type

The analyses show wide variations among the soil types in the amounts of calcium and magnesium present. Some are low in these elements, especially the sandy types. In very acid soils a sufficient amount of calcium is taken up with difficulty by growing crops from the comparatively insoluble forms in which it exists in such soils. The benefit realized from liming such soils may therefore be due, not wholly to the correction of acidity, but in part to the fact that the limestone supplies calcium as a plant-food element in a form which rapidly becomes available to crops.

Variations in the amounts of calcium and magnesium in the different depths furnish a clue as to the translocation of these elements during the long period in which the different types were developing. In the surface stratum calcium exceeds magnesium in most cases. This would indicate a larger percentage of calcium than of magnesium in the soil-forming materials. The idea is also in harmony with geological evidence. With increasing depth the concentration of calcium is usually about the same as in the surface, while in the case of magnesium the concentration increases progressively thru the middle and lower strata.

This situation may be explained by the fact that as these two elements are dissolved from the surface soil, they are carried downward in solution. In the downward movement magnesium is more readily reabsorbed by the soil mass than calcium, thus tending to force calcium into the solution to be carried farther down. Consequently, while magnesium tends to accumulate in the middle and lower strata, the liberated calcium may accumulate at still greater depths or may be washed away entirely. These movements of calcium and magnesium, as indicated by the analyses of the different strata, constitute one factor in estimating the relative maturity of the various soil types. The higher proportion of magnesium to calcium in the lower levels as compared to the surface soil tends, in general, to be accentuated with the more fully developed or mature soil profiles. Thus we see a correlation of this chemical characteristic of the soil with the processes of its development.

Some of the calcium values, as given in the tables, appear to be very erratic. The very large amounts of calcium in some of the types are an indication of the presence of finely divided native calcium carbonate (limestone). Sometimes calcium carbonate is present in the surface stratum, as in the case of Black Silt Loam with its high calcium figure of 55,570 pounds an acre. Again, being fairly soluble in the soil water calcium carbonate has leached away from the upper

TABLE 2.—HENRY COUNTY SOILS: PLANT-FOOD ELEMENTS IN UPPER SAMPLING STRATUM, ABOUT 0 TO 6⅔ INCHES[1]

Average pounds per acre in 2 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils (200, 500, 700, 800)							
226, 526, 726	Brown Silt Loam	72 030	5 030	1 190	820	32 680	8 790	12 160
520, 720	Black Clay Loam	88 650	7 290	1 740	1 350	30 690	12 710	22 010
841	Brown Fine Sandy Silt Loam	39 690	3 590	1 060	810	33 760	6 870	9 960
560, 760	Brown Sandy Loam	31 150	2 780	800	650	23 980	4 890	8 380
528, 728	Brown-Gray Silt Loam On Tight Clay	45 380	4 050	1 210	860	32 100	6 310	8 280
781	Dune Sand	12 420	1 020	480	260	17 280	3 720	5 480
	Upland Timber Soils (200, 500, 700, 800)							
234, 534, 734	Yellow-Gray Silt Loam	30 940	2 830	630	940	34 420	5 710	8 510
235, 535, 735	Yellow Silt Loam	25 600	2 270	820	390	34 100	6 980	7 530
844	Yellow-Gray Fine Sandy Silt Loam	18 160	1 820	840	480	34 820	3 920	9 940
845	Yellow Fine Sandy Silt Loam	13 650	1 470	880	440	35 490	5 920	8 960
	Terrace Soils (1500)							
1526	Brown Silt Loam	57 030	4 830	1 420	750	32 680	8 150	17 360
1520	Black Clay Loam	75 880	6 420	1 720	1 260	33 340	13 610	23 040
1517	Black Clay[2]	......	......	......	......	......	......	......
1525	Black Silt Loam	188 480	18 350	2 310	2 800	24 890	13 660	55 570
1561	Black Sandy Loam	107 270	10 490	1 300	1 250	19 500	6 160	49 040
1571	Brown Fine Sandy Loam	62 360	5 020	1 680	1 000	27 840	3 760	9 840
1560	Brown Sandy Loam	34 510	2 920	1 020	620	24 580	4 830	8 620
1528	Brown-Gray Silt Loam On Tight Clay	51 740	4 510	1 420	870	31 590	5 410	8 850
1568	Brown-Gray Sandy Loam On Tight Clay	48 070	4 200	1 130	720	24 330	4 120	6 820
1581	Dune Sand	12 080	970	810	400	19 910	3 390	7 520
	Swamp and Bottom-Land Soils (1400)							
1426	Deep Brown Silt Loam	78 150	6 010	1 540	1 040	31 660	10 420	16 460
1420	Black Clay Loam	78 900	6 380	1 950	1 130	52 710	13 660	20 990
1454	Mixed Loam[3]	......	......	......	......	......	......	......
1450	Black Mixed Loam[3]	......	......	......	......	......	......	......
1463.8	Black Mixed Sandy Loam[3]	......	......	......	......	......	......	......
1463.7	Brown Mixed Sandy Loam[3]	......	......	......	......	......	......	......
1460	Brown Sandy Loam	60 960	5 110	1 540	890	25 380	6 340	15 640
1402	Medium Peat On Clay[4]	257 570	22 650	1 500	2 120	6 420	5 670	27 770
1401	Deep Peat[4]	283 110	26 020	1 550	2 760	6 950	5 410	21 620

LIMESTONE AND SOIL ACIDITY.—In connection with these tabulated data it should be explained that the figures for limestone content and soil acidity are omitted not because of any lack of importance of these factors, but rather because of the peculiar difficulty of presenting in the form of general numerical averages reliable information concerning the limestone requirement for a given soil type. A general statement, however, will be found concerning the lime requirement of the respective soil types in connection with the discussions which follow.

[1]In obtaining the average analyses as presented here samples of some of the types taken in adjacent counties are included. [2]No samples were obtained. [3]Analytical results are not included for the Mixed Loams because of the heterogeneity of these types. [4]Amounts reported are for 1 million pounds of Deep Peat and Medium Peat On Clay.

TABLE 3.—HENRY COUNTY SOILS: PLANT-FOOD ELEMENTS IN MIDDLE SAMPLING STRATUM, ABOUT 6⅔ TO 20 INCHES[1]

Average pounds per acre in 4 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils (200, 500, 700, 800)							
226, 526, 726	Brown Silt Loam	82 480	6 870	2 010	1 300	64 790	21 510	23 380
520, 720	Black Clay Loam	113 300	8 360	2 830	2 140	62 710	28 400	41 440
841	Brown Fine Sandy Silt Loam	50 940	4 790	1 910	1 290	69 960	15 250	19 630
560, 760	Brown Sandy Loam	35 540	3 320	1 320	910	52 780	11 470	14 820
528, 728	Brown-Gray Silt Loam On Tight Clay	41 630	4 130	1 760	1 160	67 680	16 180	16 550
781	Dune Sand	14 080	1 040	720	440	31 920	6 480	10 920
	Upland Timber Soils (200, 500, 700, 800)							
234, 534, 734	Yellow-Gray Silt Loam	25 540	2 520	1 540	590	69 120	17 290	15 660
235, 535, 735	Yellow Silt Loam	19 710	1 960	1 500	520	69 640	19 650	13 990
844	Yellow-Gray Fine Sandy Silt Loam	17 160	2 320	1 720	760	73 360	11 160	21 560
845	Yellow Fine Sandy Silt Loam	13 400	1 700	2 320	840	68 820	14 120	21 220
	Terrace Soils (1500)							
1526	Brown Silt Loam	62 880	5 380	1 900	1 280	73 240	15 860	21 880
1520	Black Clay Loam	93 060	7 900	3 600	1 760	67 480	23 640	40 940
1517	Black Clay[2]	......	......	......	......	......	......	......
1525	Black Silt Loam	252 520	20 440	3 840	4 480	49 200	26 730	102 740
1561	Black Sandy Loam	69 570	5 570	1 680	1 130	41 050	11 440	48 090
1571	Brown Fine Sandy Loam	40 880	3 520	1 760	1 200	73 040	9 400	20 120
1560	Brown Sandy Loam	39 770	3 430	1 710	940	50 790	10 000	15 010
1528	Brown-Gray Silt Loam On Tight Clay	48 410	4 270	2 340	1 040	66 500	13 400	13 440
1568	Brown-Gray Sandy Loam On Tight Clay	28 250	2 650	1 870	860	54 920	10 000	12 620
1581	Dune Sand	11 950	1 050	1 350	760	39 790	6 970	15 360
	Swamp and Bottom-Land Soils (1400)							
1426	Deep Brown Silt Loam	90 700	6 040	1 960	1 040	63 180	22 960	29 900
1420	Black Clay Loam	95 410	8 050	3 150	1 540	66 420	28 730	40 760
1454	Mixed Loam[3]	......	......	......	......	......	......	......
1450	Black Mixed Loam[3]	......	......	......	......	......	......	......
1463.8	Black Mixed Sandy Loam[3]	......	......	......	......	......	......	......
1463.7	Brown Mixed Sandy Loam[3]	......	......	......	......	......	......	......
1460	Brown Sandy Loam	67 690	5 950	2 570	1 120	52 640	16 440	39 400
1402	Medium Peat on Clay[4]	226 300	20 480	1 860	3 910	20 800	11 980	47 520
1401	Deep Peat[4]	521 320	44 010	2 610	5 690	12 870	9 660	44 830

LIMESTONE AND SOIL ACIDITY.—See note in Table 2.

[1]In obtaining the average analyses as presented here samples of some of the types taken in adjacent counties are included. [2]No samples were obtained. [3]Analytical results are not included for the Mixed Loams because of the heterogeneity of these types. [4]Amounts reported are for 2 million pounds of Deep Peat and Medium Peat On Clay.

TABLE 4.—HENRY COUNTY SOILS: PLANT-FOOD ELEMENTS IN LOWER SAMPLING STRATUM, ABOUT 20 TO 40 INCHES[1]

Average pounds per acre in 6 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils (200, 500, 700, 800)							
226, 526, 726	Brown Silt Loam	40 560	4 100	2 580	1 470	100 660	43 710	39 940
520, 720	Black Clay Loam	46 560	3 510	3 710	1 540	97 370	48 540	55 130
841	Brown Fine Sandy Silt Loam	30 910	3 440	2 870	1 460	102 560	29 870	33 110
560, 760	Brown Sandy Loam	22 730	1 970	1 710	1 010	75 360	19 140	27 360
528, 728	Brown-Gray Silt Loam On Tight Clay	29 220	3 240	2 990	740	99 990	41 570	32 900
781	Dune Sand	9 900	540	1 020	900	50 100	12 480	17 940
	Upland Timber Soils (200, 500, 700, 800)							
234, 534, 734	Yellow-Gray Silt Loam	18 120	2 490	3 140	970	100 790	40 740	30 160
235, 535, 735	Yellow Silt Loam	18 730	2 110	2 730	610	105 220	39 140	41 020
844	Yellow-Gray Fine Sandy Silt Loam	15 360	2 220	3 600	1 320	106 740	24 000	37 200
845	Yellow Fine Sandy Silt Loam	15 000	1 740	3 840	930	103 650	24 960	38 460
	Terrace Soils (1500)							
1526	Brown Silt Loam	36 450	3 130	2 910	1 020	106 740	34 680	32 580
1520	Black Clay Loam	47 130	4 590	4 230	1 770	103 410	35 910	51 990
1517	Black Clay[2]	......	......	......	......	......	......	......
1525	Black Silt Loam	75 090	8 370	4 810	1 460	84 630	48 100	225 450
1561	Black Sandy Loam	32 360	2 140	1 960	1 060	66 780	21 280	40 400
1571	Brown Fine Sandy Loam	22 320	2 280	2 580	1 020	95 400	16 380	31 020
1560	Brown Sandy Loam	22 820	2 170	2 000	760	75 210	16 350	22 050
1528	Brown-Gray Silt Loam On Tight Clay	29 610	3 180	3 000	930	90 170	31 280	26 930
1568	Brown-Gray Sandy Loam On Tight Clay	21 060	2 080	2 720	940	73 660	19 640	19 450
1581	Dune Sand	11 690	810	1 760	710	59 990	18 330	36 490
	Swamp and Bottom-Land Soils (1400)							
1426	Deep Brown Silt Loam	49 290	3 390	2 730	540	102 210	36 030	42 210
1420	Black Clay Loam	67 700	5 290	4 850	1 940	95 570	45 820	67 400
1454	Mixed Loam[3]	......	......	......	......	......	......	......
1450	Black Mixed Loam[3]	......	......	......	......	......	......	......
1463.8	Black Mixed Sandy Loam[3]	......	......	......	......	......	......	......
1463.7	Brown Mixed Sandy Loam[3]	......	......	......	......	......	......	......
1460	Brown Sandy Loam	57 260	3 860	3 500	1 280	72 320	43 900	162 540
1402	Medium Peat On Clay	76 440	5 820	3 240	1 800	60 540	66 720	625 860
1401	Deep Peat[4]	531 750	40 380	2 860	8 120	25 510	17 580	163 660

LIMESTONE AND SOIL ACIDITY.—See note in Table 2.

[1]In obtaining the average analyses as presented here samples of some of the types taken in adjacent counties are included. [2]No samples were obtained. [3]Analytical results are not included for the Mixed Loams because of the heterogeneity of these types. [4]Amounts reported are for 3 million pounds of Deep Peat.

stratum of some soils but is still present in abundance in the middle or in the lower stratum. Brown Sandy Loam, Bottom, illustrates such a condition. Here the lower stratum has 162,540 pounds of calcium in 6 million pounds of soil, which after being converted to the 2-million pound basis for comparison with the surface stratum is found to be more than three times as concentrated. The lower stratum in this case contains a large amount of calcium carbonate which has not yet been leached away, and this is responsible for the high value for total calcium.

Some increase in total magnesium will be observed accompanying the high calcium of the carbonate-containing soils. These are not great, however, because of the inability of magnesium to exist long in the soil as carbonate. The carbonate of carbonate-containing soils is chiefly calcium carbonate.

Local Tests for Soil Acidity Often Required

It is impracticable to attempt to obtain an average quantitative measure of the calcium carbonate present or of the lime requirement in many soil types because while some samples may contain large amounts of carbonate others may contain none and, on the other hand, may actually have a lime requirement owing to the soil acidity. We thus have what may be considered positive and negative values ranging, perhaps widely, on the opposite sides of the zero or neutral point, the numerical average of which could have no significance whatever since it would not necessarily even approach the condition actually existing in a given farm or field. It is for this reason that the tables contain no figures purporting to represent either the lime requirement or the limestone present in the different soil types.

The qualitative tests made in the field in the process of the soil survey are much more numerous than the chemical analyses made in the laboratory and do give a general idea of the predominating condition in the various types as to acidity or alkalinity. These tests, therefore, furnish the basis for some general recommendations, which are given in the descriptions of individual types on pages 16 to 26. To have a sound basis for the application of limestone, the owner or operator of a farm must frequently determine individually the lime requirements of his different fields. The section in the Appendix dealing with the application of limestone (page 35) is pertinent and should be read in this connection.

Supplies of Different Elements Not Proportional to Crop Removal

In the foregoing discussion consideration has been given mainly to the amounts of the plant-food elements in the surface 6⅔ inches of soil, and rather briefly the relative amounts in the two lower strata have been discussed. It has been noted that some of the elements of plant food exhibit no consistent change in amount with increasing depth. Other elements show more or less marked variation at the different levels, the trend of these variations serving in some cases as clues to the relative maturity of different soil types and the processes involved in their development.

By adding together the figures for all three strata, we have an approximate invoice of the total plant-food elements within the reach of most of our common

field crops since their feeding range is included mainly in the upper 40 inches of soil. One of the most striking facts brought out of this consideration of the data is the great variation within a given soil type in the relative abundance of the various elements present as compared to the amounts removed by crops. For example, in the most extensive type in the county, Brown Silt Loam, Upland, we find that the total quantity of nitrogen in all three strata is 16,000 pounds. This is about the amount of nitrogen contained in the same number of bushels of corn. The amount of phosphorus is only about a third as much, or 5,780 pounds, but this amount is equivalent to the phosphorus in more than twice as much corn, namely, 34,000 bushels. The total stock of potassium, amounting in this type to 198,130 pounds an acre, would furnish this element for more than a million bushels of corn.

Service of Chemical Analysis in Soil Improvement

The foregoing discussion should not be taken to mean that it is possible to predict how long any certain soil could be cropped under a given system before it would become exhausted. Nor do the figures alone necessarily indicate the immediate procedure to be followed in the improvement of a soil. It must be kept in mind that the amount of plant-food substances shown to be present is not the sole measure of the ability of a soil to produce crops. The *rate* at which some of these elements are liberated from insoluble forms and converted to forms that can be used by growing plants is a matter of at least equal importance, as explained on page 33, and is not necessarily proportional to the total stocks present. One must know, therefore, how to cope with the peculiarities of a given soil type if he is to secure the full benefit from its stores of plant-food elements. In addition there are always economic factors that must be taken into consideration, since it is necessary for one to decide at how high a level of productive capacity he can best afford to maintain his soil.

The chemical soil analysis made in connection with the soil survey is seen to be of value chiefly in two ways. In the first place it reveals at once outstanding deficiencies or other chemical characteristics which alone would affect its productivity to a marked extent or point the way to corrective measures. It should be borne in mind, however, that fairly wide departures from the usual are necessary before the chemical analysis alone can be followed as a guide in practice without supplementary information from other sources. It is quite probable that the results of the soil analysis are frequently misused by attempting to interpret small differences in the amount of a certain plant-food element as indicative of similar differences in the fertilizer need.

The second function of soil analysis is as an aid in the scientific study of soils from many angles, the ultimate aim of which is, of course, the more economical utilization of the soil for efficient crop production. Not only do chemical studies aid in determining the processes involved in soil development under natural conditions, but also in determining the effects of different soil management and fertilizing practices upon the soil itself and in furthering our knowledge of the interrelations between the soil and growing crops, a knowledge which is fundamental to improvement in the efficiency of crop production.

DESCRIPTION OF SOIL TYPES

UPLAND PRAIRIE SOILS

The upland prairie soils of Henry county occupy 407.58 square miles, or almost exactly 50 percent of the area of the county. These soils were originally well supplied with organic matter derived very largely from the fibrous roots of the prairie grasses that grew on this land for centuries. A covering of fine soil and a mat of vegetative material, by partially excluding the oxygen, protected these roots from rapid and complete decay. From time to time the mat of old grass stems and leaves was partially destroyed by prairie fires and decay, but it was constantly being renewed, and while it added but little organic matter to the soil directly, it served to retard the decay of the roots of the grasses.

Brown Silt Loam (226, 526, 726)

Brown Silt Loam, Upland, as mapped in Henry county, covers an area of 373.6 square miles, or nearly 46 percent of the county. The type as originally mapped is now recognized to consist of three types each having a characteristic topography. These three types which, taken together, constitute Brown Silt Loam as shown on the soil map, may be described as follows:

Light Brown Silt Loam. This type occupies the tops of low hills and ridges and the more pronounced slopes. Its development has been associated with the relatively rapid removal of the surface soil by erosion and with good surface drainage and underdrainage. These conditions have resulted, in this region, in the formation of a soil which is very friable thruout its entire profile. The A_1 horizon, or surface soil, is about 8 inches in thickness and is a light brown silt loam. The A_2 horizon, or subsurface, extends to 15 or 20 inches in depth and has a yellowish brown color which gradually changes to a reddish brown in the B horizon, or upper subsoil. Slight gray mottling appears at a depth of 30 to 35 inches where the less-weathered parent material is found. Effervescence with acid probably never occurs in the 40-inch section of this soil and is not usually found within 60 inches of the surface.

Management.—Light Brown Silt Loam is not strongly acid but requires an application of limestone to grow red clover satisfactorily, and it will not grow alfalfa or sweet clover without the addition of limestone. The conditions of its formation have not been favorable for the accumulation of organic matter and it is lower in this essential soil constituent than is usual for the prairie soils in this region. The best information available on the treatment of this type comes from the Mt. Morris experiment field, which is located in part on Light Brown Silt Loam. The results from this field show a very marked response to manure. Where limestone was applied in addition to manure, a further increase was secured which was sufficiently large to pay a good profit on the cost of the limestone. Another treatment which gave very good increases on this field was residues and limestone used in combination. Potash has not increased the yields. Rock phosphate when used in addition to manure and limestone has not increased yields, and when used in addition to residues and limestone the yields have been increased just about enough to pay for applying half a ton of the rock per acre once in the rotation. For further account of these experiments see page 46.

Brown Silt Loam. This type occupies intermediate topographic positions. It differs from the preceding type, Light Brown Silt Loam, in having a darker and usually thicker A_1 horizon or surface, and a heavier, less friable, and somewhat mottled B horizon or upper subsoil.

Management.—Brown Silt Loam is somewhat less acid than Light Brown Silt Loam but requires limestone to grow alfalfa or sweet clover. It was originally well supplied with organic matter and has been subject to but little loss of soil material thru erosion. The Kewanee experiment field is located, for the most part, on this soil type. Unfortunately this field has several draws crossing the plots which are a much heavier soil, so that the results from the field cannot be applied to Brown Silt Loam with as much confidence as would otherwise be the case. It is almost certainly true, however, that the presence of the heavier type on the Kewanee field has the effect of diminishing the increases due to treatment. The records from this field show good results for manure with corn and oats and fair results with wheat. Limestone has given moderate increases both in the manure and in the residues system. Rock phosphate has increased the yield of wheat on the manure plots by 4.9 bushels but has had little or no effect on the other crops in the rotation. On the residues plots rock phosphate has caused very satisfactory increases in the yields of corn, oats, and wheat, and has increased the yield of clover hay by a fifth of a ton. The comparison of rock and acid phosphate on the Kewanee field has been in progress too short a time to allow final conclusions. A detailed description and history of the Kewanee experiments will be found beginning on page 48. The only concrete suggestion for the phosphate fertilization of this soil type which can be made at the present time is to make a trial of one of the phosphates, applying it for the wheat crop.

Brown Silt Loam on Clay. This type occupies the nearly level or only gently sloping areas in the upland prairie region. It is characterized by a dark brown A_1 horizon, or surface, about 10 inches thick; a brown A_2 horizon, or subsurface, containing pale yellow spots; and a B horizon, or upper subsoil, which is usually a strongly mottled, brownish yellow, somewhat compact and plastic clay loam. At a depth of 32 to 40 inches the more friable C horizon, or lower subsoil, is found.

Management.—This type is either not acid or only slightly so. The subsoil, while more compact and plastic than that of either of the preceding types discussed, drains well with tile. The Aledo experiment field is located on Brown Silt Loam On Clay, and the results from this field may be used as a guide in the treatment of this soil type in Henry county. Manure has given very good returns. Limestone has failed to give very convincing increases and its indiscriminate use could hardly be advised unless alfalfa or sweet clover is to be grown. Rock phosphate has not caused increases in yield on the manure plots but its use on the residues plots has resulted in sufficiently large increases to justify advising its application when manure is not available. Phosphate comparisons have been in progress on the Aledo field since 1916, and the reader is asked to turn to page 55 of this Report and make a study of the results as an aid in solving his phosphate problem on Brown Silt Loam On Clay.

Black Clay Loam (520, 720)

This upland phase of Black Clay Loam is a minor type in Henry county, occupying a total area of less than a square mile. It occurs as small, low-lying areas in the dark-colored upland portion of the county. It has a deep A_1 horizon, or surface soil, consisting of black clay loam or silty clay loam. The A_2 horizon, or subsurface, is a drabbish black clay loam and occurs at a depth of 12 to 18 inches. The *B* horizon, or upper subsoil, is found at a depth of about 24 inches and consists of a gray clay loam heavily colored with reddish brown spots and concretions. The more friable *C* horizon, or lower subsoil, occurs at a depth of about 36 inches. It is a strongly mottled, reddish brown, silty clay loam. The color of this horizon changes to gray at a depth of 38 or 40 inches.

Management.—Black Clay Loam, Upland, as it occurs in Henry county is likely to be alkaline tho not all of the areas have this characteristic. None of the areas, so far as is known, need limestone. The only treatment advised is the use of potash where alkali is present in harmful amounts and the plowing down of fresh organic matter as an aid in keeping the soil in good physical condition.

Brown Fine Sandy Silt Loam (841)

Brown Fine Sandy Silt Loam occupies a total area in this county of about 30 square miles. The character of this type varies somewhat depending on topography. In the hilly portion of the type the surface is a very light brown fine sandy loam underlain by yellow fine sandy loam with no visibly distinguishable subsurface or subsoil development. Carbonates occur at a depth of 20 to 30 inches on many of the hills. On the low divides and low hills the soil is different in that the surface is darker and the subsurface and subsoil are sufficiently well formed to be distinguishable, tho there is no compactness in the subsoil and mottling is absent. Carbonates are rarely found in the 40-inch section in this phase of the type. A third phase of the type occurs on the gentle slopes, the soil differing here from that on the low hills and low divides chiefly in having a lightly mottled and slightly compact subsoil. Still another phase of this same type occurs in the low level areas; it is characterized by a darker surface and a well-mottled and fairly compact medium-plastic subsoil.

Management.—Brown Fine Sandy Silt Loam is a productive soil, very easy to work. Particular attention should be given to maintaining a supply of fresh organic matter. A light application of limestone is needed for alfalfa or sweet clover. There are no experiment field data upon which to draw for definite statements regarding its fertilization. The use of manure will prove profitable and the trial of the various phosphates is suggested.

Brown Sandy Loam (560, 760)

Brown Sandy Loam, Upland, is a minor type in Henry county, its total area being only about 1¼ square miles. It is found in association with Dune Sand and occurs in depressions or low-lying areas between ridges or low hills formed by the drifting of the sand. This type varies in character, in some places having such a coarse subsoil as to be drouthy and of little value. In general the

A_1 horizon, or surface, is a brown sandy loam; the A_2 horizon, or subsurface, a yellowish brown sandy loam; and the *B* horizon, or upper subsoil, a slightly clayey sandy loam.

Management.—Brown Sandy Loam, Upland, should be cropped and managed in such a way as to provide for regular and frequent additions of either leguminous organic matter or manure. The type is not strongly acid but most of it requires some limestone to grow good sweet clover.

Brown-Gray Silt Loam On Tight Clay (528, 728)

The upland phase of Brown-Gray Silt Loam On Tight Clay is another one of the minor types in Henry county, aggregating a total of only one square mile. It occurs chiefly between Cambridge and Bishop Hill. The A_1 horizon, or surface soil, is about 8 inches thick and is a grayish brown silt loam. The A_2 horizon, or subsurface, is a gray or brownish gray silt loam, about 10 inches in thickness. The *B* horizon, or upper subsoil, is heavy and plastic and is not readily permeable to air, water, or plant roots.

Management.—The chief problem in the management of this type is to secure drainage. Underdrainage is not successful and furrows and open ditches must therefore be depended on for the removal of excess water.

Dune Sand (781)

Dune Sand, Upland, occupies all told only about a square mile. It differs in no essential, other than that of position, from Dune Sand, Terrace, and the reader is therefore referred to the discussion of the latter type (page 24).

UPLAND TIMBER SOILS

The upland timber soils are found fairly well distributed thruout the county, adjacent to the streams. Usually they are characterized by a yellow or yellowish gray color, owing to their low organic-matter content. This lack of organic matter has been caused by the long-continued growth of forest trees. As the forests invaded the prairies, the following effects were produced: the shading of the trees prevented the growth of grasses, the roots of which are mainly responsible for the large amount of organic matter in the prairie soils; and the trees themselves added very little organic matter to the soil, for the leaves and branches either decayed or were destroyed by forest fires. The timber soils cover about 104 square miles, or about 13 percent of the area of the county.

Yellow-Gray Silt Loam (234, 534, 734)

Yellow-Gray Silt Loam occupies a total area of 22 square miles in Henry county. The topography of the type varies from flat to rolling, and associated with this variation is also a variation in the character of the soil. The rolling, well-drained areas have a brownish gray A_1 horizon, or surface, a yellowish brown A_2 horizon, or subsurface, and a friable, slightly compact, reddish yellow *B* horizon, or upper subsoil. The *C* horizon, or lower subsoil, is a mottled, pale yellow, friable, fine sandy loam. The soil on the intermediate slopes differs from the above in having a distinctly gray subsurface, a mottled, medium-compact

upper subsoil, and brownish-red iron stains and concretions thruout the upper and lower subsoil.

The flat areas have a gray silt loam A_1 horizon, or surface, a light gray A_2 horizon, or subsurface, and a very compact, strongly mottled, plastic, pale yellow clay loam B horizon, or upper subsoil.

Management.—The differences within this type, as noted above, should be taken into account in planning a management program. The rolling land is subject to harmful erosion, while the intermediate slopes and flat areas do not wash. The friable subsoil found in the rolling land favors good underdrainage, while the underdrainage of the flat areas is poor. As a rule the rolling land is less acid than the flat land. The entire type is low in organic matter and nitrogen. These deficiencies should be corrected by growing clover, preferably sweet clover, following the application of limestone. No experiment field data is available for this soil type as it occurs in Henry county; consequently no definite recommendations can be made for its fertilization. It is suggested, however, that the reader turn to the discussion of "Principles of Soil Fertility," page 30, and make use of the information found in that discussion in forming his plans for fertilizer treatment.

Yellow Silt Loam (235, 535, 735)

Yellow Silt Loam covers a total of nearly 60 square miles in Henry county. It occurs for the most part as the inner timber soil belt adjacent to the bottom land along streams. Much of this type as it occurs in Henry county is too steep for cultivation and is used for pasture and timber. It is not uncommon, however, to see slopes under cultivation which are so steep as to be subject to serious erosion. No attempt is made to describe the soil itself because it varies so greatly. The separation of Yellow Silt Loam as a type is really based upon topographic rather than upon soil characteristics.

Some suggestions regarding the possibility of controlling erosion on this kind of land are given in an account of the Vienna experiment field, page 60.

Yellow-Gray Fine Sandy Silt Loam (844)

A total of nearly 11 square miles of Yellow-Gray Fine Sandy Silt Loam occurs in Henry county. The character of its profile bears the same relation to topography as was described for Yellow-Gray Silt Loam, page 19. The A_1 horizon, or surface, is a grayish yellow fine sandy loam. The A_2 horizon, or subsurface, is a reddish yellow or grayish yellow fine sandy loam depending on topography. The B horizon, or upper subsoil, is usually a reddish brown, medium-compact, non-plastic, fine sandy silt loam. This soil has been formed under timber vegetation from the wind-blown material which was blown upon the upland from the terrace.

Management.—For suggestions regarding the management of this type the reader is referred to the management paragraph for Yellow-Gray Silt Loam.

Yellow Fine Sandy Silt Loam (845)

There is an aggregate of nearly 12 square miles of Yellow Fine Sandy Silt Loam in Henry county. This type has no uniformly developed profile, its

topography being such that erosion is more or less active, depending largely on its vegetative cover. Most of the type should be used for pasture or timber. Many of the slopes are well adapted to growing alfalfa and frequently no lime is needed for alfalfa because erosion has exposed the underlying calcareous material. The possibility of orcharding might well be considered by owners of this land.

TERRACE SOILS

Large areas of terrace soils occur in Henry county as a result of the changes which have occurred in the river systems. The terraces were formed by overloaded and flooded streams which deposited an immense amount of material in the old channels. Later as the streams diminished in size or cut their channels deeper, new bottoms were developed, leaving the old flood plains above the overflow and thus forming terraces. These terrace formations which were built up, for the most part, during and immediately following the Glacial period, were later covered to varying depths with wind-blown material from which the present soils were formed.

Brown Silt Loam (1526)

Nearly 83 square miles of Brown Silt Loam, Terrace, is shown on the soil map of Henry county. The areas of this type which occupy the higher portions in the undulating terrace plain are similar to Brown Silt Loam, which occupies the intermediate topographic positions on the upland (see page 17). The areas occupying the lower-lying positions differ from the higher areas in that they have a slightly grayer A_2 horizon, or subsurface, and a very gray B horizon, or subsoil. These lower-lying areas are sometimes alkaline.

Management.—Brown Silt Loam, Terrace, is a productive soil with the exception of small areas which are so situated as to be alkaline or to have an unfavorable subsoil. Limestone is needed, except on the low areas, for alfalfa and sweet clover and for the best growth of red clover. Potash can be successfully used to correct the harmful effects of alkali, and the underdrainage of these low spots should be improved. This type was originally well supplied with organic matter but much of it is now beginning to show a deficiency in this important soil constituent. If any of the phosphates are used they should be applied at first in an experimental way, as the information available is not sufficient to warrant recommending their use on a large scale.

Black Clay Loam (1520)

Black Clay Loam, Terrace, is a rich, highly productive soil. Portions of the type need better drainage and alkali is present in places. There is a total of over 15 square miles of the type in the county.

The A_1 horizon, or surface, is a black clay loam or silty clay loam which varies from 9 to 12 inches in thickness. The A_2 horizon, or subsurface, extends to a depth of 19 to 22 inches, is a drab clay loam, and in places contains reddish brown iron spots. The B horizon, or upper portion of the subsoil, is medium-plastic drab clay or clay loam, sometimes containing reddish brown spots and concretions, while the lower portion, usually beginning at a depth of about 36 inches, is gray heavily colored with reddish brown.

Management.—Black Clay Loam, Terrace, rarely needs lime, and for the ordinary field crops it is questionable whether it will respond profitably to fertilization. Particular care should be used to provide for plowing down fresh organic matter at frequent intervals; otherwise this soil will rapidly become difficult to work. The work on the Hartsburg experiment field located on Black Clay Loam on Drab Clay is of interest in this connection. An account of the results on that field will be found on page 59.

Black Clay (1517)

Black Clay occurs in one large area of 12.78 square miles north of Atkinson. Portions of this area are better described as clay loam rather than clay. The water table is high and there is considerable alkali present. During seasons of high rainfall the crops suffer from excess water. The A_1, or surface, horizon is principally black clay, passing into the drabbish black clay A_2, or subsurface, horizon at a depth of about 8 inches. At a depth of about 15 inches the color becomes drab, and at about 20 inches a marly gray clay is frequently encountered.

Management.—Black Clay is a rich soil but must be worked with care because of its heavy nature. Organic materials should be plowed down to help keep it in good physical condition. No fertilizer treatment is advised other than the application of potash where necessary to counteract the alkali.

Black Silt Loam (1525)

Black Silt Loam is a soil formed under swampy conditions. Frequently it is strongly alkaline and the subsoil in many places is marly. It occupies a total of about 17.5 square miles in Henry county.

The surface soil varies from a black silt loam to a black silty clay loam. It frequently contains sufficient carbonates to effervesce strongly with acid. The subsurface is a drabbish-black clay loam or silty clay loam, and the subsoil is usually either a strongly mottled, rusty yellow, sandy clay loam or a more or less pure marl.

Management.—Improved drainage is the chief requirement of this type. Limestone should not be added, as carbonates are already present in excess. The bad effects of the alkali may be counteracted by the use of potash for corn. The application of coarse manure is also advised as an additional means of counteracting the effects of the alkali.

Black Sandy Loam (1561)

Black Sandy Loam is similar in formation to the preceding type, Black Silt Loam. It is much less extensive, occupying a total of about 6 square miles. It is sometimes alkaline. The surface, or A_1 horizon, varies from a brown to black sandy loam. The subsurface, or A_2 horizon, usually extending to a depth of about 21 inches, is a drabbish brown sandy silt loam. The subsoil, or B horizon, is a drab sandy clay loam, usually resting on gray sand at a depth of about 36 inches.

Management.—Fresh organic matter should be regularly plowed down in this soil. In places the underlying sand stratum is near enough to the surface

to make the soil drouthy. Limestone is ordinarily not needed on this type, tho it is much more likely to be needed than on Black Silt Loam because of the leachy subsoil.

Brown Fine Sandy Loam (1571)

Brown Fine Sandy Loam, Terrace, is a minor type in Henry county, aggregating little more than one square mile. It occurs in the northeast corner of the county. The surface, or A_1 horizon, is a light brown fine sandy loam resting at a depth of 7 or 8 inches on the subsurface, or A_2 horizon, which is a slightly reddish brown fine sandy loam. The subsoil, or B horizon, which is found at a depth of about 18 inches, is a reddish yellow, friable, fine sandy silt loam. Usually a reddish yellow sand occurs at a depth of about 36 inches.

Management.—This type is low in organic matter and nitrogen and is medium acid. Following the application of 2 to 3 tons of limestone an acre, it will grow good alfalfa or sweet clover. Corn or the small grains will do well following the turning down of clover.

Brown Sandy Loam (1560)

Brown Sandy Loam, Terrace, is pretty well distributed thruout the northern part of Henry county and covers a total area of nearly 30 square miles. This type has been subject to more or less movement by wind action and consequently much of it has not developed very definite subsurface and subsoil strata. The surface, or A_1 horizon, to a depth of 8 or 10 inches is usually a light brown sandy loam. It usually rests on a yellowish brown sandy loam which becomes more yellow and more sandy with depth. In some places there is enough accumulation of fine particles in the subsoil, or B horizon, to give it some cohesion.

Management.—Brown Sandy Loam, Terrace, is medium acid, low in organic matter and nitrogen, and where there is no accumulation of fine particles in the subsoil, it is likely to be drouthy. This soil grows good sweet clover following the application of limestone. If the sweet clover is plowed down, good corn or small grain can be grown. A clover crop should be grown every third or fourth year and utilized, at least in part, for soil improvement.

Brown-Gray Silt Loam On Tight Clay (1528)

Brown-Gray Silt Loam On Tight Clay, Terrace, occupies about 7 square miles in Henry county. The surface, or A_1 horizon, is a grayish brown silt loam, in places containing so much sand as to be sandy loam. The subsurface, or A_2 horizon, usually extending to a depth of about 17 inches, is a gray or grayish drab silt loam to sandy loam. The subsoil, or B horizon, varies considerably in color and in sand content but is impervious and plastic. In some places this impervious layer or horizon extends to over 40 inches in depth, and in other places it rests on gray sand at a depth of about 36 inches.

Management.—Both the surface drainage and the underdrainage of this type are poor. The soil is medium to strongly acid. Much of the land is used for pasture. Its value as pasture can be greatly increased by applications of limestone and the seeding of sweet clover, and probably pasture is the best use to which it can be put.

Brown-Gray Sandy Loam On Tight Clay (1568)

Less than one square mile of Brown-Gray Sandy Loam On Tight Clay, Terrace, as mapped, occurs in Henry county. The reader is referred to the discussion of the preceding type, 1528, as that discussion applies to this type also. The sandy loam, however, is a poorer soil than the silt loam.

Dune Sand (1581)

Dune Sand, Terrace, occupies nearly 18.5 square miles in Henry county. It has been subject to much movement by the wind and has developed few of the characteristics of a true soil. The surface is a light brown sand and rests at a depth of 6 or 7 inches on yellow sand. No further signs of the usual characteristic subsurface or subsoil development appear.

Management.—Dune Sand is somewhat acid and the correction of this condition by the use of limestone is the first step towards the profitable utilization of this type. The Oquawka experiment field is located on Dune Sand and very striking results have been secured there with limestone and manure, and limestone and sweet clover. The reader is referred to page 63, where the crop yields on this field are given. The information given by these figures is the best available for Dune Sand, either Terrace or Upland, as it occurs in Henry county.

SWAMP AND BOTTOM-LAND SOILS

The following group of soil types includes the bottom lands along the streams and certain poorly drained lowlands. The total area of this group, consisting of nine soil types, is a little over 110 square miles.

Deep Brown Silt Loam (1426)

Deep Brown Silt Loam occurs in the bottom lands in the southern half of the county. It is most extensively developed along Edwards river. The soil is a deep, rich silt loam. It has no distinct subsoil development, because of its youth.

Management.—Much of this land is subject to overflow and is farmed in such a way as to avoid many of the harmful effects of flood water. No fertilizer treatment is advised on any of this type which is subject to overflow. The areas not subject to overflow should be treated in the same way as Brown Silt Loam, Upland, which it resembles (see page 17).

Black Clay Loam (1420)

Black Clay Loam, Bottom, is a minor type in Henry county occupying a total area of about 1¼ square miles. This type is very similar to Black Clay Loam, Upland, and for a description of it and for suggestions regarding its management the reader is referred to the discussion of that type, page 18.

Mixed Loam (1454)

Mixed Loam occurs along the streams where conditions are such that different kinds of soil material have been washed in and deposited, resulting in what is called Mixed Loam. The soil is young and no distinct horizons have yet

been formed. Most of this type is farmed and it produces good crops, tho the farming plan has to take into account the overflow to which this land is subject. The large area of this type in the northwest corner of the county has some alkali spots, the effects of which can be overcome with potash. The areas which are not subject to overflow show slight to medium acidity, indicating the need of a moderate application of lime in a well-planned program of soil improvement, (see Brown Silt Loam, page 17).

Black Mixed Loam (1450)

Black Mixed Loam differs from Mixed Loam, 1454, in that it contains much more organic matter, has more heavy spots scattered thru it, is usually more poorly drained, and has more alkali spots. It is a productive soil and needs no treatment other than the use of potash where alkali is present, the improvement of the drainage where possible, and the provision for the addition of fresh organic matter at intervals of four or five years.

Black Mixed Sandy Loam (1463.8)

Black Mixed Sandy Loam is not essentially different from the preceding type, Black Mixed Loam (1450), except that, aside from the generally higher percentage of sand in the soil, many sandy spots are present, too small to be shown on the map. This type should be handled in the same general way as Black Mixed Loam but with more attention to the addition of organic matter.

Brown Mixed Sandy Loam (1463.7)

Brown Mixed Sandy Loam is a minor type in Henry county, aggregating only about 1⅓ square miles. It is low in organic matter and is medium acid. It is frequently underlain by nearly pure sand at a depth of about 36 inches. Because of its drouthy nature this land if farmed should be cropped to wheat, barley, or rye rather than to corn. Limestone should be used and legumes grown to furnish organic matter and nitrogen.

Brown Sandy Loam (1460)

Brown Sandy Loam, Bottom, is very similar to Brown Mixed Sandy Loam described above. It differs from it in being uniformly a sandy loam. The two types should be handled in the same way.

Medium Peat On Clay (1402)

Three small areas of Medium Peat On Clay, aggregating 122 acres, were identified at the time the soil map was made. They were located about three miles northeast of Annawan. The peat, which was less than 30 inches in thickness at that time, disappeared rapidly under cultivation, and it no longer exists as Medium Peat On Clay. These areas are now similar to the surrounding type, Black Silt Loam, and should be handled in the same way as that type.

Deep Peat (1401)

A considerable acreage of Deep Peat, aggregating 7.47 square miles, occurs in Henry county. It consists of a deposit of black, well-decomposed organic matter, frequently 5 or 6 feet in thickness. Its location near sandy areas has resulted in the drifting of sand to the Peat, frequently in sufficient amount to change the type, since the map was made, from Peat to Black Sandy Loam.

FIG. 5.—ONION HARVEST ON DEEP PEAT

Management.—The water table is high in most of the Deep Peat areas. Drainage is secured by means of dredge ditches. Some of this land is used for trucking and is good for this purpose. It often contains sufficient alkali to be harmful and requires the use of potash. Some experiments on Deep Peat on a field located at Manito are described on page 64.

APPENDIX

EXPLANATIONS FOR INTERPRETING THE SOIL SURVEY

CLASSIFICATION OF SOILS

In order to interpret the soil map intelligently, the reader must understand something of the method of soil classification upon which the survey is based. Without going far into details the following paragraphs are intended to furnish a brief explanation of the general plan of classification used.

The soil type is the unit of classification. Each type has definite characteristics upon which its separation from other types is based. These characteristics are inherent in the strata, or "horizons," which constitute the soil profile in all mature soils. Among them may be mentioned color, structure, texture, and chemical composition. Other items, such as native vegetation (whether timber or prairie), topography, and geological origin and formation, may assist in the differentiation of types, altho they are not fundamental to it.

Since some of the terms used in designating the factors which are taken into account in establishing soil types are technical in nature, the following definitions are introduced:

Horizon. A layer or stratum of soil which differs discernibly from those adjacent in color, texture, structure, chemical composition, or a combination of these characteristics, is called an horizon. In describing a matured soil, three horizons designated as *A, B,* and *C* are usually considered.

A designates the upper horizon and, as developed under the conditions of a humid, temperate climate, represents the layer of extraction or eluviation; that is to say, material in solution or in suspension has passed out of this zone thru the processes of weathering.

B represents the layer of concentration or illuviation; that is, the layer developed as a result of the accumulation of material thru the downward movement of water from the *A* horizon.

C designates the layer lying below the *B* horizon and in which the material has been less affected by the weathering processes.

Frequently differences within a stratum or zone are discernible, in which case it is subdivided and described under such designations as A_1, and A_2, B_1, and B_2, etc.

Soil Profile. The soil section as a whole is spoken of as the soil profile.

Depth and Thickness. The horizons or layers which make up the soil profile vary in depth and thickness. These variations are distinguishing features in the separation of soils into types.

Physical Composition. The physical composition, sometimes referred to as "texture," is a most important feature in characterizing a soil. The texture depends upon the relative proportions of the following physical constituents: clay, silt, fine sand, sand, gravel, stones, and organic material.

Structure. The term "structure" has reference to the aggregation of particles within the soil mass and carries such qualifying terms as open, granular, compact, columnar, laminated.

Organic-Matter Content. The organic matter of soil is derived largely from plant tissue and it exists in a more or less advanced stage of decomposition. Organic matter forms the predominating constituent in certain soils of swampy formation.

Color. Color is determined to a large extent by the proportion of organic matter, but at the same time it is modified by the mineral constituents, especially by iron compounds.

Reaction. The term "reaction" refers to the chemical state of the soil with respect to acid or alkaline condition. It also involves the idea of degree, as strongly acid or strongly alkaline.

Carbonate Content. The carbonate content has reference to the calcium carbonate (limestone) present, which in some cases may be associated with magnesium or other carbonates. The depth at which carbonates are found may become a very important factor in determining the soil type.

Topography. Topography has reference to the lay of the land, as level, rolling, hilly, etc.

Native Vegetation. The vegetation or plant growth before being disturbed by man, as prairie grasses and forest trees, is a feature frequently recognized in differentiating soil types.

Geological Origin. Geological origin involves the idea of character of rock materials composing the soil as well as the method of formation of the soil material.

Not infrequently areas are encountered in which type characters are not distinctly developed or in which they show considerable variation. When these variations are considered to have sufficient significance, type separations are made whenever the areas involved are sufficiently large. Because of the almost infinite variability occurring in soils, one of the exacting tasks of the soil surveyor is to determine the degree of variation which is allowable for any given type.

Classifying Soil Types.—In the system of classification used, the types fall first into four general groups based upon their geological relationships; namely, upland, terrace, swamp and bottom land, and residual. These groups may be subdivided into prairie soils and timber soils, altho as a matter of fact this subdivision is applied in the main only to the upland group. These terms are all explained in the foregoing part of this report in connection with the description of the particular soil types.

Naming and Numbering Soil Types.—In the Illinois soil survey a system of nomenclature is used which is intended to make the type name convey some idea of the nature of the soil. Thus the name "Yellow-Gray Silt Loam" carries in itself a more or less definite description of the type. It should not be assumed, however, that this system of nomenclature makes it possible to devise type names which are adequately descriptive, because the profile of mature soils is usually made up of three or more horizons and it is impossible to describe each horizon in the type name. The color and texture of the surface soil are usually included in the type name and when material such as sand, gravel, or rock lies at a depth of less than 30 inches, the fact is indicated by the word "On," and when its depth exceeds 30 inches, by the word "Over"; for example, Brown Silt Loam On Gravel, and Brown Silt Loam Over Gravel.

As a further step in systematizing the listing of the soils of Illinois, recognition is given to the location of the types with respect to the geological areas in which they occur. According to a geological survey made many years ago, the state has been divided into seventeen areas with respect to geological formation and, for the purposes of the soil survey, each of these areas has been assigned an index number. The names of the areas together with their general location and their respective index numbers are given in the following list.

000 *Residual,* soils formed in place thru disintegration of rocks, and also rock outcrop
100 *Unglaciated,* including three areas, the largest being in the south end of the state
200 *Illinoisan moraines,* including the moraines of the Illinoisan glaciations
300 *Lower Illinoisan glaciation,* formerly considered as covering nearly the south third of the state
400 *Middle Illinoisan glaciation,* covering about a dozen counties in the west-central part of the state
500 *Upper Illinoisan glaciation,* covering about fourteen counties northwest of the middle Illinoisan glaciation
600 *Pre-Iowan glaciation,* but now believed to be part of the upper Illinoisan
700 *Iowan glaciation,* lying in the central northern end of the state
800 *Deep loess areas,* including a zone a few miles wide along the Wabash, Illinois, and Mississippi rivers
900 *Early Wisconsin moraines,* including the moraines of the early Wisconsin glaciation
1000 *Late Wisconsin moraines,* including the moraines of the late Wisconsin glaciation

1100 *Early Wisconsin glaciation,* covering the greater part of the northeast quarter of the state
1200 *Late Wisconsin glaciation,* lying in the northeast corner of the state
1300 *Old river-bottom and swamp lands,* formed by material derived from the Illinoisan or older glaciations
1400 *Late river-bottom and swamp lands,* formed by material derived from the Wisconsin and Iowan glaciations
1500 *Terraces,* bench or second bottom lands, and gravel outwash plains
1600 *Lacustrine deposits,* formed by Lake Chicago, the enlarged glacial Lake Michigan.

Further information regarding these geological areas is given in connection with the general map mentioned above and published in Bulletin 123 (1908).

Another set of index numbers is assigned to the classes of soils as based upon physical composition. The following list contains the names of these classes with their corresponding index numbers.

Index Number Limits	Class Names
0 to 9	Peats
10 to 12	Peaty loams
13 to 14	Mucks
15 to 19	Clays
20 to 24	Clay loams
25 to 49	Silt loams
50 to 59	Loams
60 to 79	Sandy loams
80 to 89	Sands
90 to 94	Gravelly loams
95 to 97	Gravels
98	Stony loams
99	Rock outcrop

As a convenient means of designating types and their location with respect to the geological areas of the state, each type is given a number made up of a combination of the index numbers explained above. This number indicates the type and the geological area in which it occurs. The geological area is always indicated by the digits of the order of hundreds while the remainder of the number designates the type. To illustrate: the number 1126 means Brown Silt Loam in the early Wisconsin glaciation, 434 means Yellow-Gray Silt Loam of the middle Illinois glaciation. These numbers are especially useful in designating very small areas on the map and as a check in reading the colors.

A complete list of the soil types occurring in each county, along with their corresponding type numbers and the area covered by each type, will be found in the respective county soil reports in connection with the maps.

SOIL SURVEY METHODS

Mapping of Soil Types.—In conducting the soil survey, the county constitutes the unit of working area. The field work is done by parties of two to four men each. The field season extends from early in April to the last of November. During the winter months the men are engaged in preparing a copy of the soil map to be sent to the lithographer, a copy for use of the county farm adviser until the printed map is available, and a third copy for use in the office in order to preserve the original official map in good condition.

An accurate base map for field use is necessary for soil mapping. These maps are prepared on a scale of one inch to the mile, the official data of the original or subsequent land survey being used as the basis in their construction.

FIG. 6.—EXAMINING THE SOIL PROFILE

Each surveyor is provided with one of these base maps, which he carries with him in the field; and the soil type boundaries, together with the streams, roads, railroads, canals, town sites, and rock and gravel quarries are placed in their proper location upon the map while the mapper is on the area. With the rapid development of road improvement during the past few years, it is almost inevitable that some recently established roads will not appear on the published soil map. Similarly, changes in other artificial features will occasionally occur in the interim between the preparation of the map and its publication. The detail or minimum size of areas which are shown on the map varies somewhat, but in general a soil type if less than five acres in extent is not shown.

Sampling for Analysis.—After all the soil types of a county have been located and mapped, samples representative of the different types are collected for chemical analysis. The samples for this purpose are usually taken in three depths; namely, 0 to 6⅔ inches, 6⅔ to 20 inches, and 20 to 40 inches, as explained in connection with the discussion of the analytical data on page 7.

PRINCIPLES OF SOIL FERTILITY

Probably no agricultural fact is more generally known by farmers and landowners than that soils differ in productive power. A fact of equal importance, not so generally recognized, is that they also differ in other characteristics such as response to fertilizer treatment and to management.

The soil is a dynamic, ever-changing, exceedingly complex substance made up of organic and inorganic materials and teeming with life in the form of microorganisms. Because of these characteristics, the soil cannot be considered as a reservoir into which a given quantity of an element or elements of plant food can be poured with the assurance that it will respond with a given increase in crop yield. In a similar manner it cannot be expected to respond with perfect uniformity to a given set of management standards. To be productive a soil must be in such condition physically with respect to structure and moisture as to encourage root development; and in such condition chemically that injurious substances are not present in harmful amounts, that a sufficient supply of the elements of plant food become available or usable during the growing season, and that lime materials are present in sufficient abundance favorable for the growth of the higher plants and of the beneficial microorganisms. Good soil management under humid conditions involves the adoption of those tillage, crop-

ping, and fertilizer treatment methods which will result in profitable and permanent crop production on the soil type concerned.

The following paragraphs are intended to state in a brief way some of the principles of soil management and treatment which are fundamental to profitable and continued productivity.

CROP REQUIREMENTS WITH RESPECT TO PLANT-FOOD MATERIALS

Ten of the chemical elements are known to be essential for the growth of the higher plants. These are *carbon, hydrogen, oxygen, nitrogen, phosphorus, sulfur, potassium, calcium, magnesium,* and *iron.* Other elements are absorbed

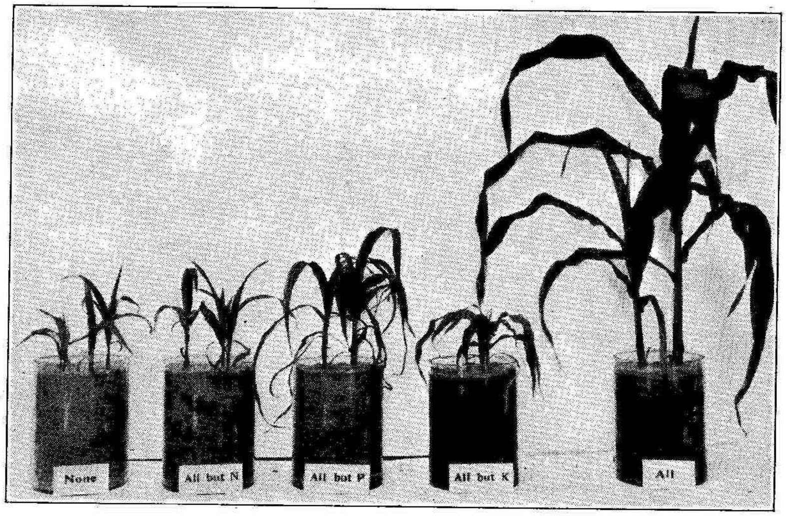

FIG. 7.—ALL ESSENTIAL PLANT-FOOD ELEMENTS MUST BE PRESENT

The jars in which these corn plants are growing contain pure sand to which have been added various combinations of the essential plant-food elements. If a single one of these elements is omitted, the plants cannot develop; they die after the small supply stored in the seed becomes exhausted.

from the soil by growing plants, including manganese, silicon, sodium, aluminum, chlorin, and boron. It is probable that these latter elements are present in plants for the most part, not because they are required, but because they are dissolved in the soil water and the plant has no means of preventing their entrance. There is some evidence, however, which indicates that certain of these elements, notably manganese, silicon, and boron, may be either essential but required in only minute quantities, or very beneficial to plant growth under certain conditions, even tho not essential. Thus, for example, manganese has produced marked increases in crop yields on heavily limed soils. Sodium also has been found capable of partially replacing potassium in case of a shortage of the latter element.

Table 5 shows the requirements of some of our most common field crops with respect to seven important plant-food elements furnished by the soil. The

TABLE 5.—PLANT-FOOD ELEMENTS IN COMMON FARM CROPS[1]

Produce		Nitrogen	Phosphorus	Sulfur	Potassium	Magnesium	Calcium	Iron
Kind	Amount							
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Wheat, grain......	1 bu.	1.42	.24	.10	.26	.08	.02	.01
Wheat straw......	1 ton	10.00	1.60	2.80	18.00	1.60	3.80	.60
Corn, grain.......	1 bu.	1.00	.17	.08	.19	.07	.01	.01
Corn stover.......	1 ton	16.00	2.00	2.42	17.33	3.33	7.00	1.60
Corn cobs........	1 ton	4.00	....	....	4.00	....	....	....
Oats, grain.......	1 bu.	.66	.11	.06	.16	.04	.02	.01
Oat straw........	1 ton	12.40	2.00	4.14	20.80	2.80	6.00	1.12
Clover seed.......	1 bu.	1.75	.50	....	.75	.25	.13	....
Clover hay.......	1 ton	40.00	5.00	3.28	30.00	7.75	29.25	1.00
Soybean seed.....	1 bu.	3.22	.39	.27	1.26	.15	.14	....
Soybean hay......	1 ton	43.40	4.74	5.18	35.48	13.84	27.56	....
Alfalfa hay.......	1 ton	52.08	4.76	5.96	16.64	8.00	22.26	....

[1]These data are brought together from various sources. Some allowance must be made for the exactness of the figures because samples representing the same kind of crop or the same kind of material frequently exhibit considerable variation.

figures show the weight in pounds of the various elements contained in a bushel or in a ton, as the case may be. From these data the amount of an element removed from an acre of land by a crop of a given yield can easily be computed.

PLANT-FOOD SUPPLY

Of the elements of plant food, three (carbon, oxygen, and hydrogen) are secured from air and water, and the others from the soil. Nitrogen, one of the elements obtained from the soil by all plants, may also be secured from the air by the class of plants known as legumes, in case the amount liberated from the soil is insufficient; but even these plants, which include only the clovers, peas, beans, and vetches among our common agricultural plants, are dependent upon the soil for the other six elements (phosphorus, potassium, magnesium, calcium, iron, and sulfur), and they also utilize the soil nitrogen so far as it becomes soluble and available during their period of growth.

The vast difference with respect to the supply of these essential plant-food elements in different soils is well brought out in the data of the Illinois soil survey. For example, it has been found that the nitrogen in the surface 6⅔ inches, which represents the plowed stratum, varies in amount from 180 pounds per acre to more than 35,000 pounds. In like manner the phosphorus content varies from about 320 to 4,900 pounds, and the potassium ranges from 1,530 to about 58,000 pounds. Similar variations are found in all of the other essential plant-food elements of the soil.

With these facts in mind it is easy to understand how a deficiency of one of these elements of plant food may become a limiting factor of crop production. When an element becomes so reduced in quantity as to become a limiting factor of production, then we must look for some outside source of supply. Table 6 is presented for the purpose of furnishing information regarding the quantity

TABLE 6.—PLANT-FOOD ELEMENTS IN MANURE, ROUGH FEEDS, AND FERTILIZERS[1]

Material	Pounds of plant food per ton of material		
	Nitrogen	Phosphorus	Potassium
Fresh farm manure	10	2	8
Corn stover	16	2	17
Oat straw	12	2	21
Wheat straw	10	2	18
Clover hay	40	5	30
Cowpea hay	43	5	33
Alfalfa hay	50	4	24
Sweet clover (water-free basis)[2]	80	8	28
Dried blood	280	.....	.....
Sodium nitrate	310	.....	.....
Ammonium sulfate	400	.....	.....
Raw bone meal	80	180	.....
Steamed bone meal	20	250	.....
Raw rock phosphate	.....	250	.....
Acid phosphate	.....	125	.....
Potassium chlorid	.....	.....	850
Potassium sulfate	.....	.....	850
Kainit	.....	.....	200
Wood ashes[3] (unleached)	.....	10	100

[1]See footnote to Table 5.
[2]Young second-year growth ready to plow under as green manure.
[3]Wood ashes also contain about 1,000 pounds of lime (calcium carbonate) per ton.

of some of the more important plant-food elements contained in materials most commonly used as sources of supply.

LIBERATION OF PLANT FOOD

The chemical analysis of the soil gives the invoice of plant-food elements actually present in the soil strata sampled and analyzed, but the rate of liberation is governed by many factors, some of which may be controlled by the farmer, while others are largely beyond his control. Chief among the important controllable factors which influence the liberation of plant food are the choice of crops to be grown, the use of limestone, and the incorporation of organic matter. Tillage, especially plowing, also has a considerable effect in this connection.

Feeding Power of Plants.—Different species of plants exhibit a very great diversity in their ability to obtain plant food directly from the insoluble minerals of the soil. As a class, the legumes—especially such biennial and perennial legumes as red clover, sweet clover, and alfalfa—are endowed with unusual power to assimilate from mineral sources such elements as calcium and phosphorus, converting them into available forms for the crops that follow. For this reason it is especially advantageous to employ such legumes in connection with the application of limestone and rock phosphate. Thru their growth and subsequent decay large quantities of the mineral elements are liberated for the benefit of the cereal crops which follow in the rotation. Moreover, as an effect of the deep-rooting habit of these legumes, mineral plant-food elements are brought up and rendered available from the vast reservoirs of the lower subsoil.

Effect of Limestone.—Limestone corrects the acidity of the soil and supplies calcium, thus encouraging the development not only of the nitrogen-gathering bacteria which live in the nodules on the roots of clover, cowpeas, and other legumes, but also the nitrifying bacteria, which have power to transform the unavailable organic nitrogen into available nitrate nitrogen. At the same time, the products of this decomposition have power to dissolve the minerals contained in the soil, such as potassium and magnesium compounds.

Organic Matter and Biological Action.—Organic matter may be supplied thru animal manures, consisting of the excreta of animals and usually accompanied by more or less stable litter; and by plant manures, including green-manure crops and cover crops plowed under, and also crop residues such as stalks, straw, and chaff. The rate of decay of organic matter depends largely upon its age, condition, and origin, and it may be hastened by tillage. The chemical analysis shows correctly the total organic carbon, which constitutes, as a rule, but little more than half the organic matter; so that 20,000 pounds of organic carbon in the plowed soil of an acre corresponds to nearly 20 tons of organic matter. But this organic matter consists largely of the old organic residues that have accumulated during the past centuries because they were resistant to decay, and 2 tons of clover or cowpeas plowed under may have greater power to liberate plant-food materials than 20 tons of old, inactive organic matter. The history of the individual farm or field must be depended upon for information concerning recent additions of active organic matter, whether in applications of farm manure, in legume crops, or in sods of old pastures.

The condition of the organic matter of the soil is indicated to some extent by the ratio of carbon to nitrogen. Fresh organic matter recently incorporated with the soil contains a very much higher proportion of carbon to nitrogen than do the old resistant organic residues of the soil. The proportion of carbon to nitrogen is higher in the surface soil than in the corresponding subsoil, and in general this ratio is wider in highly productive soils well charged with active organic matter than in very old, worn soils badly in need of active organic matter.

The organic matter furnishes food for bacteria, and as it decays certain decomposition products are formed, including much carbonic acid, some nitrous acid, and various organic acids, and these acting upon the soil have the power to dissolve the essential mineral plant foods, thus furnishing available phosphates, nitrates, and other salts of potassium, magnesium, calcium, etc., for the use of the growing crop.

Effect of Tillage.—Tillage, or cultivation, also hastens the liberation of plant-food elements by permitting the air to enter the soil. It should be remembered, however, that tillage is wholly destructive, in that it adds nothing whatever to the soil, but always leaves it poorer, so far as plant-food materials are concerned. Tillage should be practiced so far as is necessary to prepare a suitable seed bed for root development and also for the purpose of killing weeds, but more than this is unnecessary and unprofitable; and it is much better actually to enrich the soil by proper applications of limestone, organic matter, and other fertilizing materials, and thus promote soil conditions favorable for vigorous plant growth, than to depend upon excessive cultivation to accomplish the same object at the expense of the soil.

PERMANENT SOIL IMPROVEMENT

According to the kind of soil involved, any comprehensive plan contemplating a permanent system of agriculture will need to take into account some of the following considerations.

The Application of Limestone

The Function of Limestone.—In considering the application of limestone to land it should be understood that this material functions in several different ways, and that a beneficial result may therefore be attributable to quite diverse causes. Limestone provides calcium, of which certain crops are strong feeders. It corrects acidity of the soil, thus making for some crops a much more favorable environment as well as establishing conditions absolutely required for some of the beneficial legume bacteria. It accelerates nitrification and nitrogen fixation. It promotes sanitation of the soil by inhibiting the growth of certain fungous diseases, such as corn-root rot. Experience indicates that it modifies either directly or indirectly the physical structure of fine-textured soils, frequently to their great improvement. Thus, working in one or more of these different ways, limestone often becomes the key to the improvement of worn lands.

How to Ascertain the Need for Limestone.—One of the most reliable indications as to whether a soil needs limestone is the character of the growth of certain legumes, particularly sweet clover and alfalfa. These crops do not thrive in acid soils. Their successful growth, therefore, indicates the lack of sufficient acidity in the soil to be harmful. In case of their failure to grow the soil should be tested for acidity as described below. A very valuable test for ascertaining the need of a soil for limestone is found in the potassium thiocyanate test for soil acidity. It is desirable to make the test for carbonates along with the acidity test. Limestone is calcium carbonate, while dolomite is the combined carbonates of calcium and magnesium. The natural occurrence of these carbonates in the soil is sufficient assurance that no limestone is needed, and the acidity test will be negative. On lands which have been treated with limestone, however, the surface soil may give a positive test for carbonates, owing to the presence of undecomposed pieces of limestone, and at the same time a positive test for acidity may be secured. Such a result means either that insufficient limestone has been added to neutralize the acidity, or that it has not been in the soil long enough to entirely correct the acidity. In making these tests, it is desirable to examine samples of soil from different depths, since carbonates may be present, even in abundance, below a surface stratum that is acid. Following are the directions for making the tests:

The Potassium Thiocyanate Test for Acidity. This test is made with a 4-percent solution of potassium thiocyanate in alcohol—4 grams of potassium thiocyanate in 100 cubic centimeters of 95-percent alcohol.[1] When a small quantity of soil shaken up in a test tube with this solution gives a red color the soil is acid and limestone should be applied. If the solution remains colorless the soil is not acid. An excess of water interferes with the reaction. The sample when tested, therefore, should be at least as dry as when the soil is in

[1] Since undenatured alcohol is difficult to obtain, some of the denatured alcohols have been tested for making this solution. Completely denatured alcohol made over U. S. Formulas No. 1 and No. 4, have been found satisfactory. Some commercial firms are also offering other preparations which are satisfactory.

good tillable condition. For a prompt reaction the temperature of the soil and solution should be not lower than that of comfortable working conditions (60° to 75° Fahrenheit).

The Hydrochloric Acid Test for Carbonates. Take a small representative sample of soil and pour upon it a few drops of hydrochloric (muriatic) acid, prepared by diluting the concentrated acid with an equal volume of water. The presence of limestone or some other carbonates will be shown by the appearance of gas bubbles within 2 or 3 minutes, producing foaming or effervescence. The absence of carbonates in a soil is not in itself evidence that the soil is acid or that limestone should be applied, but it indicates that the confirmatory potassium thiocyanate test should be carried out.

Amounts to Apply.—Acid soils should be treated with limestone whenever such application is at all practicable. The initial application varies with the degree of acidity and will usually range from 2 to 6 tons an acre. The larger amounts will be needed on strongly acid soils, particularly on land being prepared for alfalfa. When sufficient limestone has been used to establish conditions favorable to the growth of legumes, no further applications are necessary until the acidity again develops to such an extent as to interfere with the best growth of these crops. This will ordinarily be at intervals of several years. In the case of an inadequate supply of magnesium in the soil, the occasional use of magnesian (dolomitic) limestone would serve to correct this deficiency. Otherwise, so far as present knowledge indicates, either form of limestone—high-calcium or magnesian—will be equally effective, depending upon the purity and fineness of the respective stones.

Fineness of Material.—The fineness to which limestone is ground is an important consideration in its use for soil improvement. Experiments indicate that a considerable range in this regard is permissible. Very fine grinding insures ready solubility, and thus promptness in action; but the finer the grinding the greater is the expense involved. A grinding, therefore, that furnishes not too large a proportion of coarser particles along with the finer, similar to that of the by-product material on the market, is to be recommended. Altho the exact proportions of coarse and fine material cannot be prescribed, it may be said that a limestone crushed so that the coarsest fragments will pass thru a screen of 4 to 10 meshes to the inch is satisfactory if the total product is used.

The Nitrogen Problem

Nitrogen presents the greatest practical soil problem in American agriculture. Four important reasons for this are: its increasing deficiency in most soils; its cost when purchased on the open market; its removal in large amounts by crops; and its loss from soils thru leaching. Nitrogen usually costs from four to five times as much per pound as phosphorus. A 100-bushel crop of corn requires 150 pounds of nitrogen for its growth, but only 23 pounds of phosphorus. The loss of nitrogen from soils may vary from a few pounds to over one hundred pounds per acre, depending upon the treatment of the soil, the distribution of rainfall, and the protection afforded by growing crops.

An inexhaustible supply of nitrogen is present in the air. Above each acre of the earth's surface there are about sixty-nine million pounds of atmospheric nitrogen. The nitrogen above one square mile weighs twenty million tons, an amount sufficient to supply the entire world for four or five decades. This large supply of nitrogen in the air is the one to which the world must eventually turn.

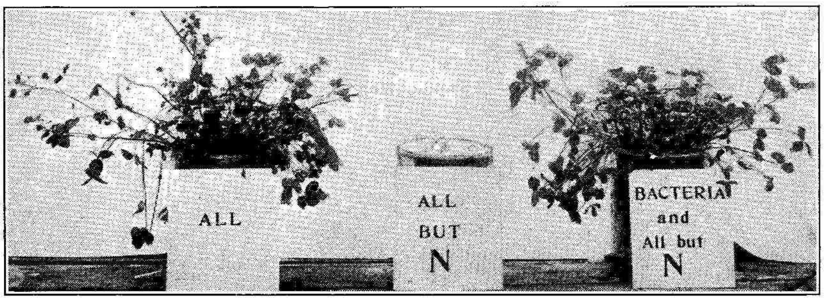

FIG. 8.—LEGUMES CAN OBTAIN THEIR NITROGEN FROM THE AIR

The photograph tells the story of how clover benefits the soil. In the pot at the left all the essential plant-food elements, including nitrogen, are supplied. In the middle jar all the elements, with the single exception of nitrogen, are present. At the right nitrogen is likewise withheld but the proper bacteria are supplied which enable the clover to secure nitrogen from the air.

There are two methods of collecting the inert nitrogen gas of the air and combining it into compounds that will furnish products for plant growth. These are the chemical and the biological fixation of the atmospheric nitrogen. Farmers have at their command one of these methods. By growing inoculated legumes, nitrogen may be obtained from the air, and by plowing under more than the roots of these legumes, nitrogen may be added to the soil.

Inasmuch as legumes are worth growing for purposes other than the fixation of atmospheric nitrogen, a considerable portion of the nitrogen thus gained may be considered a by-product. Because of that fact, it is questionable whether the chemical fixation of nitrogen will ever be able to replace the simple method of obtaining atmospheric nitrogen by growing inoculated legumes in the production of our great grain and forage crops.

It may well be kept in mind that the following amounts of nitrogen are required for the produce named:

1 bushel of oats (grain and straw) requires 1 pound of nitrogen.
1 bushel of corn (grain and stalks) requires 1½ pounds of nitrogen.
1 bushel of wheat (grain and straw) requires 2 pounds of nitrogen.
1 ton of timothy contains 24 pounds of nitrogen.
1 ton of clover contains 40 pounds of nitrogen.
1 ton of cowpea hay contains 43 pounds of nitrogen.
1 ton of alfalfa contains 50 pounds of nitrogen.
1 ton of average manure contains 10 pounds of nitrogen.
1 ton of young sweet clover, at about the stage of growth when it is plowed under as green manure, contains, on water-free basis, 80 pounds of nitrogen.

The roots of clover contain about half as much nitrogen as the tops, and the roots of cowpeas contain about one-tenth as much as the tops. Soils of moderate productive power will furnish as much nitrogen to clover (and two or three times as much to cowpeas) as will be left in the roots and stubble. In grain crops, such as wheat, corn, and oats, about two-thirds of the nitrogen is contained in the grain and one-third in the straw or stalks.

The Phosphorus Problem

The element phosphorus is an indispensable constituent of every living cell. It is intimately connected with the life processes of both plants and animals, the nuclear material of the cells being especially rich in this element.

The phosphorus content of the soil is dependent upon the origin of the soil. The removal of phosphorus by continuous cropping slowly reduces the amount of this element in the soil available for crop use, unless its addition is provided for by natural means, such as overflow, or by agricultural practices, such as the addition of phosphatic fertilizers and rotations in which deep-rooting, leguminous crops are frequently grown.

It should be borne in mind in connection with the application of phosphate, or of any other fertilizing material, to the soil, that no benefit can result until the need for it has become a limiting factor in plant growth. For example, if there is already present in the soil sufficient available phosphorous to produce a forty-bushel crop, and the nitrogen supply or the moisture supply is sufficient for only forty bushels, or less, then extra phosphorus added to the soil cannot increase the yield beyond this forty-bushel limit.

There are several different materials containing phosphorus which are applied to land as fertilizer. The more important of these are bone meal, acid phosphate, natural raw rock phosphate, and basic slag. Obviously that carrier of phosphorus which gives the most economical returns, as considered from all standpoints, is the most suitable one to use. Altho this matter has been the subject of much discussion and investigation the question still remains unsettled. Probably there is no single carrier of phosphorus that will prove to be the most economical one to use under all circumstances because so much depends upon soil conditions, crops grown, length of haul, and market conditions.

Bone meal, prepared from the bones of animals, appears on the market in two different forms, raw and steamed. Raw bone meal contains, besides the phosphorus, a considerable percentage of nitrogen which adds a useless expense if the material is purchased only for the sake of the phosphorus. As a source of phosphorous, steamed bone meal is preferable to raw bone meal. Steamed bone meal is prepared by extracting most of the nitrogeneous and fatty matter from the bones, thus producing a more nearly pure form of calcium phosphate containing about 10 to 12 percent of the element phosphorus.

Acid phosphate is produced by treating rock phosphate with sulfuric acid. The two are mixed in about equal amounts; the product therefore contains about one-half as much phosphorus as the rock phosphate itself. Besides phosphorus, acid phosphate also contains sulfur, which is likewise an element of plant food. The phosphorus in acid phosphate is more readily available for absorption by plants than that of raw rock phosphate. Acid phosphate of good quality should contain 6 percent or more of the element phosphorus.

Rock phosphate, sometimes called floats, is a mineral substance found in vast deposits in certain regions. The phosphorus in this mineral exists chemically as tri-calcium phosphate, and a good grade of the rock should contain 12½ percent, or more, of the element phosphorus. The rock should be ground to a powder, fine enough to pass thru a 100-mesh sieve, or even finer.

The relative cheapness of raw rock phosphate, as compared with the treated or acidulated material, makes it possible to apply for equal money expenditure considerably more phosphorus per acre in this form than in the form of acid phosphate, the ratio being, under the market conditions of the past several years,

about 4 to 1. That is to say, under these market conditions, a dollar will purchase about four times as much of the element phosphorus in the form of rock phosphate as in the form of acid phosphate, which is an important consideration if one is interested in building up a phosphorus reserve in the soil. As explained above, more very carefully conducted comparisons on various soil types under various cropping systems are needed before definite statements can be given as to which form of phosphate is most economical to use under any given set of conditions.

Basic slag, known also as Thomas phosphate, is another carrier of phosphorus that might be mentioned because of its considerable usage in Europe and eastern United States. Basic slag phosphate is a by-product in the manufacture of steel. It contains a considerable proportion of basic material and therefore it tends to influence the soil reaction.

Rock phosphate may be applied at any time during a rotation, but it is applied to the best advantage either preceding a crop of clover, which plant seems to possess an unusual power for assimilating the phosphorus from raw phosphate, or else at a time when it can be plowed under with some form of organic matter such as animal manure or green manure, the decay of which serves to liberate the phosphorous from its insoluble condition in the rock. It is important that the finely ground rock phosphate be intimately mixed with the organic material as it is plowed under.

In using acid phosphate or bone meal in a cropping system which includes wheat, it is a common practice to apply the material in the preparation of the wheat ground. It may be advantageous, however, to divide the total amount to be used and apply a portion to the other crops of the rotation, particularly to corn and to clover.

The Potassium Problem

Our most common soils, which are silt loams and clay loams, are well stocked with potassium, altho it exists largely in a slowly soluble form. Such soils as sands and peats, however, are likely to be low in this element. On such soils this deficiency may be remedied by the application of some potassium salt, such as potassium, sulfate, potassium chlorid, kainit, or other potassium compound, and in many instances this is done at great profit.

From all the facts at hand it seems, so far as our great areas of common soils are concerned, that, with a few exceptions, the potassium problem is not one of addition but of liberation. The Rothamsted records, which represent the oldest soil experiment fields in the world, show that for many years other soluble salts have had practically the same power as potassium salts to increase crop yields in the absence of sufficient decaying organic matter. Whether this action relates to supplying or liberating potassium for its own sake, or to the power of the soluble salt to increase the availability of phosphorous or other elements, is not known, but where much potassium is removed, as in the entire crops at Rothamsted, with no return of organic residues, probably the soluble salt functions in both ways.

Further evidence on this matter is furnished by the Illinois experiment field at Fairfield, where potassium sulfate has been compared with kainit both with

and without the addition of organic matter in the form of stable manure. Both sulfate and kainit produced a substantial increase in the yield of corn, but the cheaper salt—kainit—was just as effective as the potassium sulfate, and returned some financial profit. Manure alone gave an increase similar to that produced by the potassium salts, but the salts added to the manure gave very little increase over that produced by the manure alone. This is explained in part, perhaps, by the fact that the potassium removed in the crops is mostly returned in manure properly cared for, and perhaps in larger part by the fact that decaying organic matter helps to liberate and hold in solution other plant-food elements, especially phosphorus.

In laboratory experiments at the Illinois Experiment Station, it has been shown that potassium salts and most other soluble salts increase the solubility of the phosphorus in soil and in rock phosphate; also that the addition of glucose with rock phosphate in pot-culture experiments increases the availability of the phosphorous, as measured by plant growth, altho the glucose consists only of carbon, hydrogen, and oxygen, and thus contains no limiting element of plant food.

In considering the conservation of potassium on the farm it should be remembered that in average livestock farming the animals destroy two-thirds of the organic matter and retain one-fourth of the nitrogen and phophorus from the food they consume, but that they retain less than one-tenth of the potassium; so that the actual loss of potassium in the products sold from the farm, either in grain farming or in livestock farming, is negligible on land containing 25,000 pounds or more of potassium in the surface 6⅔ inches.

The Calcium and Magnesium Problem

When measured by crop removals of the plant-food elements, calcium is often more limited in Illinois soils than is potassium, while magnesium may be occasionally. In the case of calcium, however, the deficiency is likely to develop more rapidly and become much more marked because this element is leached out of the soil in drainage water to a far greater extent than is either magnesium or potassium.

The annual loss of limestone from the soil depends, of course, upon a number of factors aside from those which have to do with climatic conditions. Among these factors may be mentioned the character of the soil, the kind of limestone, its condition of fineness, the amount present, and the sort of farming practiced. Because of this variation in the loss of lime materials from the soil, it is impossible to prescribe a fixed practice in their renewal that will apply universally. The tests for acidity and carbonates described above, together with the behavior of such lime-loving legumes as alfalfa and sweet clover, will serve as general indicators for the frequency of applying limestone and the amount to use on a given field.

Limestone has a direct value on some soils for the plant food which it supplies, in addition to its value in correcting soil acidity and in improving the physical condition of the soil. Ordinary limestone (abundant in the southern and western parts of Illinois) contains nearly 800 pounds of calcium per ton;

while a good grade of dolomitic limestone (the more common limestone of northern Illinois) contains about 400 pounds of calcium and 300 pounds magnesium per ton. Both of these elements are furnished in readily available form in ground dolomitic limestone.

The Sulfur Question

In considering the relation of sulfur in a permanent system of soil fertility it is important to understand something of the cycle of transformations that this element undergoes in nature. Briefly stated this is as follows:

Sulfur exists in the soil in both organic and inorganic forms, the former being gradually converted to the latter form thru bacterial action. In this inorganic form sulfur is taken up by plants which in their physiological processes change it once more into an organic form as a constituent of protein. When these plant proteins are consumed by animals, the sulfur becomes a part of the animal protein. When these plant and animal proteins are decomposed, either thru bacterial action, or thru combustion, as in the burning of coal, the sulfur passes into the atmosphere or into the soil solution in the form of sulfur dioxid gas. This gas unites with oxygen and water to form sulfuric acid, which is readily washed back into the soil by the rain, thus completing the cycle, from soil—to plants and animals—to air—to soil.

In this way sulfur becomes largely a self-renewing element of the soil, altho there is a considerable loss from the soil by leaching. Observations taken at the Illinois Agricultural Experiment Station show that 40 pounds of sulfur per acre are brought into the soil thru the annual rainfall. With a fair stock of sulfur, such as exists in our common types of soil, and with an annual return, which of itself would more than suffice for the needs of maximum crops, the maintenance of an adequate sulfur supply presents little reason at present for serious concern. There are regions, however, where the natural stock of sulfur in the soil is not nearly so high and where the amount returned thru rainfall is small. Under such circumstances sulfur soon becomes a limiting element of crop production, and it will be necessary sooner or later to introduce this substance from some outside source. Investigation is now under way to determine to what extent this situation may apply under Illinois conditions.

Physical Improvement of Soils

In the management of most soil types, one very important matter, aside from proper fertilization, tillage, and drainage, is to keep the soil in good physical condition, or good tilth. The constituent most important for this purpose is organic matter. Organic matter in producing good tilth helps to control washing of soil on rolling land, raises the temperature of drained soil, increases the moisture-holding capacity of the soil, slightly retards capillary rise and consequently loss of moisture by surface evaporation, and helps to overcome the tendency of some soils to run together badly.

The physical effect of organic matter is to produce a granulation or mellowness, by cementing the fine soil particles into crumbs or grains about as large as grains of sand, which produces a condition very favorable for tillage, percolation of rainfall, and the development of plant roots.

Organic matter is undergoing destruction during a large part of the year and the nitrates produced in its decomposition are used for plant growth. Altho this decomposition is necessary, it nevertheless reduces the amount of organic matter, and provision must therefore be made for maintaining the supply. The practical way to do this is to turn under the farm manure, straw, cornstalks, weeds, and all or part of the legumes produced on the farm. The amount of legumes needed depends upon the character of the soil. There are farms, especially grain farms, in nearly every community where all legumes could be turned under for several years to good advantage.

Manure should be spread upon the land as soon as possible after it is produced for if it is allowed to lie in the barnyard several months as is so often the case, from one-third to two-thirds of the organic matter will be lost.

Straw and cornstalks should be turned under, and not burned. There is considerable evidence indicating that on some soils undecomposed straw applied in excessive amount may be detrimental. Probably the best practice is to apply the straw as a constituent of well-rotted stable manure. Perhaps no form of organic matter acts more beneficially in producing good tilth than cornstalks. It is true, they decay rather slowly, but it is also true that their durability in the soil is exactly what is needed in the production of good tilth. Furthermore, the nitrogen in a ton of cornstalks is one and one-half times that of a ton of manure, and a ton of dry cornstalks incorporated in the soil will ultimately furnish as much humus as four tons of average farm manure. When burned, however, both the humus-making material and the nitrogen are lost to the soil.

It is a common practice in the corn belt to pasture the cornstalks during the winter and often rather late in the spring after the frost is out of the ground. This trampling by stock sometimes puts the soil in bad condition for working. It becomes partially puddled and will be cloddy as a result. If tramped too late in the spring, the natural agencies of freezing and thawing and wetting and drying, with the aid of ordinary tillage, fail to produce good tilth before the crop is planted. Whether the crop be corn or oats, it necessarily suffers and if the season is dry, much damage may be done. If the field is put in corn, a poor stand is likely to result, and if put in oats, the soil is so compact as to be unfavorable for their growth. Sometimes the soil is worked when too wet. This also produces a partial puddling which is unfavorable to physical, chemical, and biological processes. The effect becomes worse if cropping has reduced the organic matter below the amount necessary to maintain good tilth.

Systems of Crop Rotations

In a program of permanent soil improvement one should adopt at the outset a good rotation of crops, including, for the reasons discussed above, a liberal use of legumes. No one can say in advance for every particular case what will prove to be the best rotation of crops, because of variation in farms and farmers and in prices for produce. As a general principle the shorter rotations, with the frequent introduction of leguminous crops, are the best adapted for building up poor soils.

Following are a few suggested rotations which may serve as models or outlines to be modified according to special circumstances.

Six-Year Rotations

First year	—Corn
Second year	—Corn
Third year	—Wheat or oats (with clover)
Fourth year	—Clover
Fifth year	—Wheat (with clover)
Sixth year	—Clover, or clover and grass

In grain farming, with small grain grown the third and fifth years, most of the unsalable products should be returned to the soil, and the clover may be clipped and left on the land or returned after threshing out the seed; or, in livestock farming, the field may be used three years for timothy and clover pasture and meadow if desired. The system may be reduced to a five-year rotation by cutting out either the second or the sixth year, and to a four-year system by omitting the fifth and sixth years, as indicated below.

The two following rotations are suggested as especially adapted for combating the corn borer:

First year	—Corn
Second year	—Soybeans
Third year	—Small grain (with legume)
Fourth year	—Legume
Fifth year	—Corn (for silage)
Sixth year	—Wheat (with sweet clover)

First year	—Corn
Second year	—Soybeans
Third year	—Small grain (with legume)
Fourth year	—Legume
Fifth year	—Wheat (with alfalfa)
Sixth year	—Alfalfa

Five-Year Rotations

First year	—Corn
Second year	—Wheat or oats (with clover)
Third year	—Clover
Fourth year	—Wheat (with clover)
Fifth year	—Clover

First year	—Corn
Second year	—Soybeans
Third year	—Corn
Fourth year	—Wheat, (with legume)
Fifth year	—Legume

First year	—Corn
Second year	—Cowpeas or soybeans
Third year	—Wheat (with clover)
Fourth year	—Clover
Fifth year	—Wheat (with clover)

The last rotation mentioned above allows legumes to be grown four times. Alfalfa may be grown on a sixth field rotating over all fields if moved every six years.

Four-Year Rotations

First year	—Corn
Second year	—Wheat or oats (with clover)
Third year	—Clover
Fourth year	—Wheat (with clover)

First year	—Corn
Second year	—Corn
Third year	—Wheat or oats (with clover)
Fourth year	—Clover

First year	—Corn
Second year	—Cowpeas or soybeans
Third year	—Wheat (with clover)
Fourth year	—Clover

First year	—Wheat (with clover)
Second year	—Clover
Third year	—Corn
Fourth year	—Oats (with clover)

Alfalfa may be grown on a fifth field for four or eight years, which is to be alternated with one of the four; or the alfalfa may be moved every five years, and thus rotated over all five fields every twenty-five years.

Three-Year Rotations

First year	—Corn	*First year*	—Wheat or oats (with clover)
Second year	—Oats or wheat (with clover)	*Second year*	—Corn
Third year	—Clover	*Third year*	—Cowpeas or soybeans

By allowing the clover, in the last rotation mentioned, to grow in the spring before preparing the land for corn, we have provided a system in which legumes grow on every acre every year. This is likewise true of the following suggested two-year system:

Two-Year Rotations

First year	—Oats or wheat (with sweet clover)
Second year	—Corn

Altho in this two-year rotation either oats or wheat is suggested, as a matter of fact, by dividing the land devoted to small grain, both of these crops can be grown simultaneously, thus providing a three-crop system in a two-year cycle.

It should be understood that in all of the above suggested cropping systems it may be desirable in some cases to substitute barley or rye for the wheat or oats. Or, in some cases, it may become desirable to divide the acreage of small grain and grow in the same year more than one kind. In all of these proposed rotations the word *clover* is used in a general sense to designate either red clover, alsike clover, or sweet clover, or it may include alfalfa used as a biennial. The mixing of alfalfa with clover seed for a legume crop is a recommendable practice. In connection with livestock production it may be desirable to mix grass with the clover for pasture or hay. The value of sweet clover, especially as a green manure for building up depleted soils, as well as a pasture and hay-crop, is becoming thoroly established, and its importance in a crop-rotation program may well be emphasized.

SUPPLEMENT: EXPERIMENT FIELD DATA

(Results from Experiment Fields on Soil Types Similar to Those Occurring in Henry County)

The University of Illinois has conducted altogether about fifty soil experiment fields in different sections of the state and on varions types of soil. Altho some of these fields have been discontinued, the majority are still in operation. It is the present purpose to report the results from certain of these fields located on types of soil described in the foregoing part of this soil report.

A few general explanations at this point, which apply to all the fields, will relieve the necessity of numerous repetitions in the following pages.

Size and Arrangement of Fields

The soil experiment fields vary in size from less than two acres up to 40 acres or more. They are laid off into series of plots, the plots commonly being either one-fifth or one-tenth acre in area. Each series is occupied by one kind of crop. Usually there are several series so that a crop rotation can be carried on with every crop represented every year.

Farming Systems

On many of the fields the treatment provides for two distinct systems of farming, livestock farming and grain farming.

In the livestock system, stable manure is used to furnish organic matter and nitrogen. The amount applied to a plot is based upon the amount that can be produced from crops raised on that plot.

In the grain system no animal manure is used. The organic matter and nitrogen are applied in the form of plant manures, including the plant residues produced, such as cornstalks, straw from wheat, oats, clover, etc., along with leguminous catch crops plowed under. It is the plan in this latter system to remove from the land, in the main, only the grain and seed produced, except in the case of alfalfa, that crop being harvested for hay the same as in the livestock system. Some modifications have been introduced in recent years.

Definite Crop Rotations Followed

Crops which are of interest in the respective localities are grown in definite rotations. The most common rotation used is wheat, corn, oats, and clover; and often these crops are accompanied by alfalfa growing on a fifth series. In the grain system a legume catch crop, usually sweet clover, is included, which is seeded on the young wheat in the spring and plowed under in the fall or in the following spring in preparation for corn. If the red clover crop fails, soybeans are substituted.

Soil Treatment

The treatment applied to the plots has, for the most part, been standardized according to a rather definite system, altho deviations from this system occur now and then, particularly in the older fields.

Following is a brief explanation of this standard system of treatment.

Animal Manures.—Animal manures, consisting of excreta from animals, with stable litter, are spread upon the respective plots in amounts proportionate to previous crop yields, the applications being made in preparation for corn.

Plant Manures.—Crop residues produced on the land, such as stalks, straw, and chaff, are returned to the soil, and in addition a green-manure crop of sweet clover is seeded in small grains to be plowed under in preparation for corn. (On plots where limestone is lacking the sweet clover seldom survives.) This practice is designated as the *residue system.*

Mineral Manures.—The yearly acre-rates of application have been: for limestone, 1,000 pounds; for raw rock phosphate, 500 pounds; and for potassium, usually 200 pounds of kainit. When kainit was not available, owing to conditions brought on by the World war, potassium carbonate was used. The initial application of limestone has usually been 4 tons per acre.

Explanation of Symbols Used

0 = Untreated land or check plots
M = Manure (animal)
R = Residues (from crops, and includes legumes used as green manure)
L = Limestone
P = Phosphorus, in the form of rock phosphate unless otherwise designated (aP=acid phosphate, bP=bonemeal, rP=rock phosphate, sP=slag phosphate)
K = Potassium (usually in the form of kainit)
N = Nitrogen (usually in the form contained in dried blood)
Le = Legume used as green manure
Cv = Cover crop
( ) = Parentheses enclosing figures, signifying tons of hay, as distinguished from bushels of seed
| = Heavy vertical rule, indicating the beginning of complete treatment
|| = Double vertical rule, indicating a radical change in the cropping system

In discussions of this sort of data, financial profits or losses based upon assigned market values are frequently considered. However, in view of the erratic fluctuations in market values—especially in the past few years—it seems futile to attempt to set any prices for this purpose that are at all satisfactory. The yields are therefore presented with the thought that with these figures at hand the financial returns from a given practice can readily be computed upon the basis of any set of market values that the reader may choose to apply.

THE MT. MORRIS FIELD

The Mt. Morris experiment field was established in 1910 at Mt. Morris in Ogle county. The soil represents fairly well the type Light Brown Silt Loam, altho the plots are not altogether uniform in this respect. The plots considered here comprize four series under a rotation of corn, oats, clover, and wheat, with soil treatments as indicated in the accompanying table. The application of straw to the residues plots has been discontinued in these later years. In 1922 the application of limestone, and in 1923 the application of rock phosphate, were indefinitely suspended in order to observe the residual effect of these materials.

TABLE 7.—MT. MORRIS FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields 1913-1926—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn	Oats	Wheat	Clover[1]	Soybeans
		14 crops	*14 crops*	*12 crops*	*10 crops*	*2 crops*
1	0	45.3	58.5	23.3	(1.96)	(1.56)
2	M	59.5	67.4	28.1	(2.53)	(1.70)
3	ML	64.4	70.5	34.4	(2.97)	(1.80)
4	MLP	64.3	71.5	35.9	(2.92)	(1.92)
5	0	44.6	54.9	23.5	(1.61)	13.5
6	R	51.2	59.4	25.8	(1.77)	16.0
7	RL	62.2	68.8	32.7	(2.24)	18.9
8	RLP	65.6	70.2	36.2	(2.23)	20.7
9	RLPK	67.2	70.4	36.3	(2.24)	20.0
10	0	43.6	52.4	24.6	(1.79)	(1.68)
	Crop Increases					
	M over 0	14.2	8.9	4.8	(.57)	(.14)
	R over 0	6.6	4.5	2.3	(.16)	2.5
	ML over M	4.9	3.1	6.3	(.44)	(.10)
	RL over R	11.0	9.4	6.9	(.47)	2.9
	MLP over ML	− .1	1.0	1.5	−(.05)	(.12)
	RLP over RL	3.4	1.4	3.5	−(.01)	1.8
	RLPK over RLP	1.6	.2	.1	(.01)	− .7

[1]Some clover seed is evaluated as hay.

A summary of the results of the work is given in Table 7, in the form of the average annual crop yields for the years since the complete soil treatments have been in effect.

FIG. 9.—CORN ON THE MT. MORRIS FIELD

The two pictures represent the extremes in corn production according to soil treatment. Where the untreated land has produced as a fourteen-year average 44.6 bushels an acre, the land under the residues, limestone, phosphate, potash treatment has yielded 67.2 bushels. The most profitable treatment on this field, however, has been that of residues and limestone, which has produced 62.2 bushels an acre.

In looking over these results, one may observe first the beneficial effect of farm manure (M). The annual crop increases due to the use of manure alone amount to over 14 bushels an acre for corn, nearly 9 bushels of oats, almost 5 bushels of wheat, and about ½ ton of clover. Organic manure furnished by "residues" (R) has likewise proved beneficial to all crops, but not in the same degree as stable manure.

Limestone (L) in addition to organic manures has been used with good effect, the improvement being especially marked in the residues system.

Rock phosphate (P) has produced no significant effect applied with manure and limestone. In the corresponding residues system the increases in yield obtained from rock phosphate are somewhat larger, but they have not been sufficient to cover the cost of the phosphate applied.

Potassium (K), in the combination used in these experiments, has produced no results of significance.

THE KEWANEE FIELD

A University soils experiment field is located in Henry county about midway between Kewanee and Galva. This field has been in operation since 1915. It includes 20 acres of the dark-colored loessial soil characteristic of the region. The main soil type represented is Brown Silt Loam, altho a detailed examination reveals the presence of a second type occupying the basin of the draw which traverses the field in a winding direction. This minor type is classified as Black Clay Loam On Drab Clay. The distribution of these soil types, as well as the arrangement of plots, is charted in the accompanying diagram (Fig. 10). The topography of the land is also represented in the diagram by contour lines. As

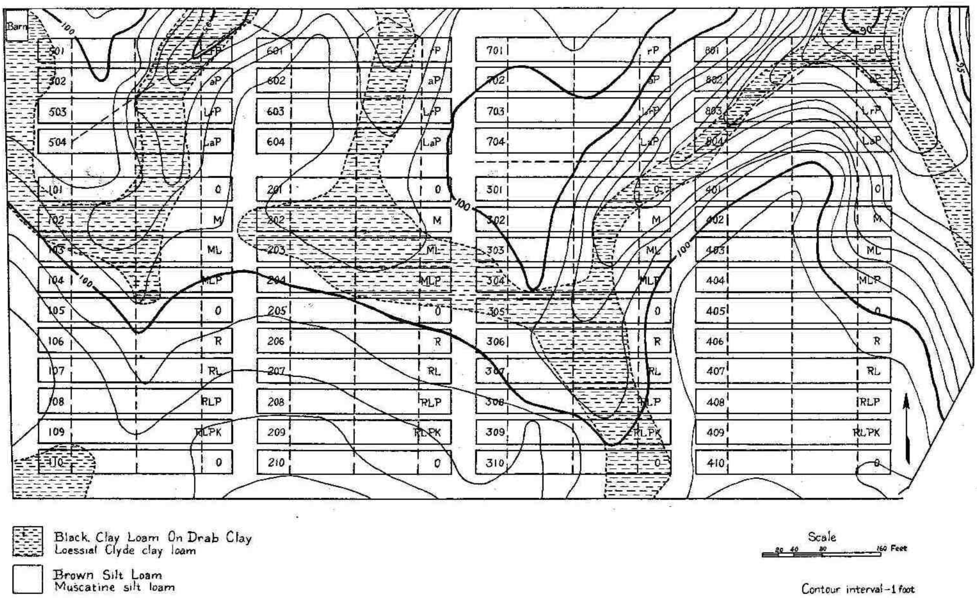

FIG. 10.—DIAGRAM OF THE KEWANEE SOIL EXPERIMENT FIELD

This diagram shows the arrangement of plots, the soil treatments applied, the location of the two soil types and, by means of contour lines, the natural drainage of the field.

these lines indicate, the land is rather rolling and it has a tendency to wash at certain spots. A thoro system of tiling has been installed on the field and the drainage is fairly satisfactory. The field is laid out in two systems of plots, each system under a separate program of crop rotation.

The 100, 200, 300, and 400 Series

The four series of plots designated as series 100, 200, 300, and 400 are each made up of 10 fifth-acre plots under the different soil treatments indicated in the accompanying tables and diagram. A rotation system of wheat, corn, oats, and clover has been practiced, the crops being managed mainly as described on page 45. Since 1921 the clover on the residues plots has been harvested for hay instead of seed and the oat straw has not been returned to the land. Since 1922 the periodic application of limestone has been suspended until it shall be needed again, and the practice of returning the wheat straw has been discontinued.

Since the Kewanee field is located in Henry county, a complete record of the yields of all crops grown is included in this report. Table 8 contains the crop yields for Series 100, 200, 300, and 400, and Table 9 gives a summary of the results showing the average annual yields for the different kinds of crops, including the years since the complete soil treatments have been in effect.

In looking over these results one may observe first the effect of animal manure (M), which has given profitable increases in all the crops. Residues alone (R), however, show no significant effect.

Limestone (L) in addition to manure has resulted in a little improvement, probably sufficient to cover the cost. It has been somewhat more effective in the grain system than in the livestock system.

Phosphorus (P), as usual, shows up in these averages to best advantage on the wheat crop in the residues system. Where used with manure and limestone, little effect was produced except on the wheat; but where used with residues and limestone, fair increases were produced in all crops, sufficient to return a financial profit under present market conditions. A detailed study of the data reveals a fact of interest in this connection which the averages do not bring out, and that is that the phosphate exerted very little influence during the earlier years of the experiments. Within the past six or seven years, however, the phosphorus treatment has come suddenly into evidence and the trend of its effectiveness seems at present to be on the upgrade.

No significant response appears as the result of potassium fertilization (K), thus indicating the futility of purchasing potassium fertilizer for use in this kind of a cropping system on this kind of soil.

The 500, 600, 700, and 800 Series

The short series (Nos. 500, 600, 700, and 800) have but 4 plots each and they constitute the so-called minor system of plots. They are now given over to a comparison of the effectiveness of rock phosphate and acid phosphate.

Alfalfa was grown on these plots until 1922. In the beginning, limestone was applied to Plots 3 and 4 at the rate of 4 tons an acre. This application was repeated in 1919. In 1922 the present experiments with phosphates were begun

TABLE 8.—KEWANEE FIELD: SERIES 100, 200, 300, 400
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1915 Corn[1]	1916 Oats[2]	1917 Clover[4]	1918 Wheat[4]	1919 Corn	1920 Oats	1921 Clover	1922 Wheat	1923 Corn	1924 Oats	1925 Clover	1926 Wheat	1927 Corn
101	0	32.6	66.4	(1.67)	13.1	55.8	62.7	(1.83)	34.8	35.0	80.0	(.97)	32.5	39.0
102	M	40.5	68.4	(2.33)	34.6	66.3	65.8	(2.48)	31.7	54.8	93.3	(1.54)	43.6	66.6
103	ML	37.3	68.3	(2.04)	26.7	69.3	74.7	(2.19)	36.6	51.5	98.9	(1.51)	49.2	67.4
104	MLP	37.5	63.6	(1.70)	32.5	67.5	75.6	(2.16)	41.0	50.8	99.7	(1.61)	56.6	73.4
105	0	38.6	69.8	.42	34.1	65.1	67.0	(1.96)	36.7	38.8	84.1	(1.31)	37.8	41.2
106	R	32.4	63.3	.54	41.0	52.4	63.0	(2.11)	39.2	49.1	80.0	(.60)	43.6	44.8
107	RL	44.2	62.3	.67	40.1	71.5	64.5	(2.04)	35.3	53.3	94.5	(.79)	53.2	53.4
108	RLP	36.3	68.1	.79	46.0	77.2	67.5	(2.58)	39.1	58.3	100.6	(1.00)	60.2	63.6
109	RLPK	41.6	64.7	.58	50.8	71.1	70.0	(2.87)	40.5	61.4	97.7	(1.05)	60.4	68.8
110	0	44.2	63.4	(1.85)	40.5	47.8	56.2	(2.50)	39.9	48.8	79.4	(1.79)	26.5	37.2
		Wheat[1]	Corn[3]	Oats	Clover	Wheat	Corn	Oats	Clover	Wheat	Corn	Oats	Clover	Wheat
201	0	33.8	42.7	72.0	(2.76)	30.1	58.1	43.9	(2.32)	29.1	51.5	55.0	(0.00)	28.2
202	M	35.0	43.7	84.4	(2.95)	27.0	65.3	53.4	(2.96)	33.7	62.0	75.8	(1.40)	38.3
203	ML	36.5	50.6	95.2	(3.07)	28.4	69.6	52.0	(3.03)	36.5	63.2	76.4	(1.79)	35.5
204	MLP	29.9	46.0	82.7	(3.35)	28.0	72.4	52.8	(3.10)	38.9	64.2	69.7	(1.39)	41.2
205	0	30.8	46.3	72.3	(1.46) .42	35.1	60.8	47.3	(2.49)	30.3	50.0	50.9	(0.00)	34.8
206	R	41.2	47.9	70.5	(1.22) .38	31.8	51.9	44.5	(2.81)	31.2	53.0	58.4	(.64)	34.9
207	RL	27.2	52.5	68.6	(1.60) .25	25.4	61.4	45.0	(2.82)	30.8	56.0	63.6	(1.13)	37.1
208	RLP	29.7	49.2	71.2	(1.67) .12	26.8	64.7	47.5	(2.94)	38.4	62.4	74.7	(1.45)	43.9
209	RLPK	28.8	54.2	77.3	(1.82) .17	28.4	68.9	46.7	(2.94)	42.2	62.1	73.9	(1.70)	46.2
210	0	31.7	45.6	67.8	(2.10)	31.8	41.0	41.4	(1.58)	24.8	45.0	49.1	(0.00)	27.0

[1]Limestone only. [2]No manure or potassium. [3]No potassium. [4]No manure.

TABLE 8.—*Concluded*

Bushels or (tons) per acre

Plot No.	Soil treatment applied	1915 Soy-beans[1]	1916 Wheat[2]	1917 Corn	1918 Oats	1919 Clover	1920 Wheat	1921 Corn	1922 Oats	1923 Clover	1924 Wheat	1925 Corn	1926 Oats	1927 Clover
301	0	19.7	17.8	47.5	59.7	(1.93)	28.3	72.6	61.7	(.87)	38.3	56.8	62.5	(1.61)
302	M	(1.78)	13.6	49.2	65.2	(1.98)	31.2	74.5	69.7	(1.49)	40.8	70.8	74.1	(2.33)
303	ML	(1.62)	10.1	56.2	67.8	(1.81)	29.3	84.2	71.6	(1.99)	46.9	73.0	74.7	(2.64)
304	MLP	(1.70)	15.5	58.5	65.2	(2.06)	35.3	78.7	72.3	(1.85)	49.4	80.4	76.9	(3.56)
305	0	20.2	12.8	44.1	55.0	(1.84)	27.2	66.2	62.0	(.54)	33.4	59.1	57.8	(2.11)
306	R	19.1	13.7	39.9	62.0	(1.16)	29.2	74.9	54.4	(.85)	35.2	61.8	52.5	(1.17)
307	RL	19.6	10.2	47.0	59.1	(1.17)	29.4	78.6	63.9	(1.31)	43.6	68.0	54.4	(1.29)
308	RLP	19.7	14.3	51.0	67.0	(1.43)	38.4	78.3	58.8	(1.71)	49.1	82.6	73.9	(1.79)
309	RLPK	22.2	16.4	57.6	70.6	(1.54)	35.9	90.3	66.9	(1.70)	49.8	77.7	79.1	(1.66)
310	0	19.7	14.8	44.0	62.5	(1.85)	31.1	69.9	50.6	(0.00)	31.0	56.2	62.2	(0.00)
		Oats[1]	Clover[3]	Wheat[5]	Corn	Oats	Clover	Wheat	Corn	Oats	Clover	Wheat	Corn	Oats
401	0	83.8	(2.43)	26.5	60.5	36.1	(.84)	25.3	52.0	54.2	(3.31)	23.4	64.2	65.8
402	M	80.0	(2.34)	27.5	66.8	43.6	(1.36)	32.0	69.0	69.4	(4.14)	24.0	69.8	78.8
403	ML	91.6	(2.51)	27.3	68.4	48.4	(1.42)	35.7	78.6	61.6	(3.53)	24.4	73.8	81.7
404	MLP	77.0	(2.04)	26.1	70.2	45.5	(1.59)	39.9	78.8	67.2	(3.89)	35.9	75.2	81.7
405	0	84.8	(4)	30.2	58.0	43.3	(.80) .29	30.6	57.5	56.4	(2.82)	20.1	58.6	70.9
406	R	77.5	(4)	34.8	69.8	43.6	(.83) .40	30.8	64.4	51.3	(3.31)	23.4	61.8	70.5
407	RL	88.1	(4)	32.0	76.8	44.1	(1.00) .40	33.8	81.3	63.9	(4.04)	29.2	66.8	70.8
408	RLP	87.8	(4)	33.2	69.4	45.3	(.89) .35	36.7	89.0	69.4	(3.91)	35.9	68.2	74.8
409	RLPK	95.6	(4)	38.7	75.7	46.4	(.81) .19	32.6	86.6	64.4	(3.90)	35.0	82.6	78.3
410	0	72.2	(1.95)	19.7	53.2	35.2	(1.03)	24.7	54.9	49.1	(2.96)	27.4	48.8	57.8

[1]Limestone only. [2]No manure or potassium. [3]Lime and residues only. [4]No seed harvested in 1916. [5]No manure.

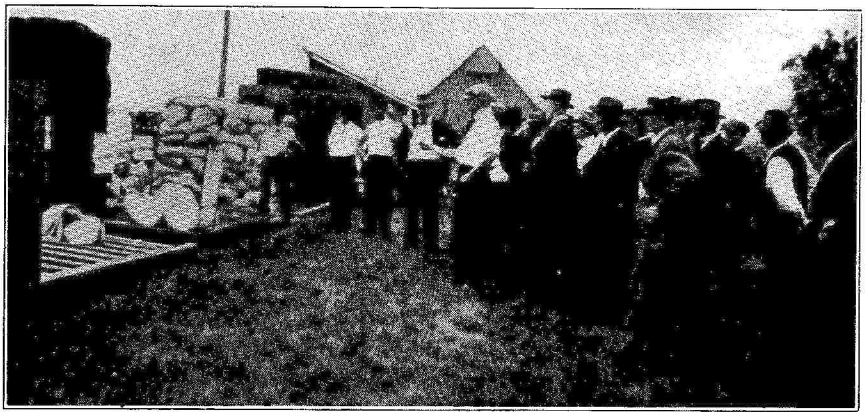

FIG. 11.—A LESSON IN SOIL MANAGEMENT ON THE KEWANEE FIELD
Field meetings are held from time to time which are attended by farmers and others interested in soil improvement. The lessons from the plots themselves are supplemented by exhibits arranged to bring out important principles of soil fertility.

and the same rotation practiced on the larger series was established on these series. In this phosphate comparison rock phosphate is used on Plots 1 and 3 at the annual rate of 400 pounds an acre, applied once in the rotation ahead of the wheat, but beginning with 1927 rock phosophate has been applied at the same time as the acid phosphate. Acid phosphate is used on Plots 2 and 4 at the annual rate of 200 pounds an acre. It is applied twice in the rotation, one-half for wheat and one-half for oats.

TABLE 9.—KEWANEE FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields 1917-1927—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Wheat 9 crops	Corn 11 crops	Oats 11 crops	Clover[1] 10 crops
1	0	30.0	53.9	59.4	(1.64)
2	M	33.6	65.0	70.3	(2.26)
3	ML	35.8	68.7	73.0	(2.30)
4	MLP	40.7	70.0	71.2	(2.46)
5	0	31.8	54.5	60.6	(1.60)
6	R	33.3	56.7	59.2	(1.55)
7	RL	35.3	64.9	61.9	(1.78)
8	RLP	40.9	69.5	68.2	(1.98)
9	RLPK	41.2	73.0	70.1	(2.03)
10	0	29.4	49.7	56.6	(1.38)
	Crop Increases				
	M over 0	3.6	11.1	10.9	(.62)
	R over 0	1.5	2.2	− 1.4	−(.05)
	ML over M	2.2	3.7	2.7	(.04)
	RL over R	2.0	8.2	2.7	(.23)
	MLP over ML	4.9	1.3	− 1.8	(.16)
	RLP over RL	5.6	4.6	6.3	(.20)
	RLPK over RLP	.3	3.5	1.9	(.05)

[1]Some clover seed is evaluated as hay.

TABLE 10.—KEWANEE FIELD: SERIES 500, 600, 700, 800
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1915 Barley	1916 Alfalfa seeding	1917 Alfalfa seeding	1918 Alfalfa seeding	1919 Alfalfa	1920 Alfalfa	1921 Corn	Soil treatment applied	1922 Wheat	1923 Corn	1924 Oats	1925 Clover	1926 Wheat	1927 Corn
501	0	19.2	....	....	....	(2.65)	(2.26)	70.7	Le rP	34.5	70.1	88.8	(2.22)	56.0	58.3
502	0	26.1	....	....	....	(2.38)	(2.40)	63.9	Le aP	38.9	68.2	90.9	(1.88)	54.4	59.1
503	L	18.2	....	....	....	(2.15)	(2.41)	71.7	LeLrP	31.8	69.7	90.6	(1.87)	51.5	56.0
504	L	23.7	....	....	....	(2.37)	(2.54)	70.0	LeLaP	40.5	66.1	98.1	(2.08)	55.7	56.5
		Barley	Alfalfa seeding	Alfalfa seeding	Alfalfa seeding	Alfalfa	Alfalfa	Alfalfa		Alfalfa	Wheat	Corn	Oats	Clover	Wheat
601	0	25.7	....	....	....	(2.48)	(2.47)	(4.57)	Le rP	(4.94)	36.4[1]	67.6	84.8	(2.29)	45.6
602	0	25.6	....	....	....	(2.47)	(2.60)	(4.32)	Le aP	(5.05)	41.4	70.2	80.0	(2.45)	46.4
603	L	22.7	....	....	....	(3.05)	(2.78)	(4.18)	LeLrP	(4.83)	33.1	70.9	70.3	(2.33)	41.7
604	L	20.2	....	....	....	(2.20)	(2.21)	(3.66)	LeLaP	(4.85)	40.1	69.1	64.8	(2.31)	46.2
		Barley	Alfalfa seeding	Alfalfa seeding	Alfalfa seeding	Alfalfa	Alfalfa	Alfalfa		Oats	Clover	Wheat	Corn	Oats	Clover
701	0	29.2	....	....	....	(2.85)	(2.61)	(4.63)	Le rP	57.5	(3.81)	50.7	80.1	80.6	(3.71)
702	0	23.8	....	....	....	(2.83)	(2.49)	(4.50)	Le aP	62.2	(4.10)	55.6	81.4	82.8	(3.69)
703	L	22.4	....	....	....	(3.80)	(3.01)	(4.36)	LeLrP	57.5	(4.07)	48.9	74.8	79.2	(3.51)
704	L	30.9	....	....	....	(2.89)	(2.58)	(3.94)	LeLaP	63.6	(3.86)	58.3	79.7	80.5	(3.47)
		Barley	Alfalfa seeding	Alfalfa seeding	Alfalfa seeding	Alfalfa	Alfalfa	Alfalfa		Corn	Oats	Clover	Wheat	Corn	Oats
801	0	25.1	....	....	....	(2.57)	(1.99)	(3.72)	Le rP	78.9	61.1	(4.03)	44.9	75.4	80.6
802	0	22.1	....	....	....	(2.25)	(1.91)	(3.72)	Le aP	75.8	72.2	(3.45)	46.0	70.6	82.2
803	L	14.7	....	....	....	(2.29)	(2.30)	(3.78)	LeLrP	77.7	67.5	(3.51)	37.4	65.8	81.1
804	L	21.8	....	....	....	(2.47)	(2.31)	(3.79)	LeLaP	80.4	68.6	(3.92)	45.7	70.0	84.7

[1]Wheat damaged by standing water in 1923.

Table 10 provides an outline of the crop history of these plots and a summary of the annual crop yields is given in Table 11.

TABLE 11.—KEWANEE FIELD: PHOSPHATE EXPERIMENT
Average Annual Crop Yields and Corresponding Money Values, 1922-1927
Bushels or (tons) per acre

Soil treatment	Wheat *6 crops*	Corn *6 crops*	Oats *6 crops*	Hay *6 crops*	Value per acre[1]
Rock phosphate..................	44.7	71.7	75.6	(3.50)	$45.41
Acid phosphate..................	47.1	70.9	78.4	(3.44)	46.06
Limestone, rock phosphate.........	40.7	69.1	74.4	(3.52)	43.72
Limestone, acid phosphate.........	47.8	70.3	76.7	(3.61)	46.60

[1]With wheat at $1.20 a bushel, corn at 68 cents, oats at 40 cents, and hay at $14 a ton, which are the average December 1 quotations for the last six years. The cost of the two phosphorus carriers are estimated at $12 a ton for the rock and $24 a ton for the acid, thus making the expense for the two kinds equal.

The difficulty in arriving at a final conclusion regarding the comparative economy in the use of these different phosphorous materials is obvious, for all depends upon their relative cost, which fluctuates from time to time. Furthermore the prices received from farm produce likewise fluctuate; and to complicate matters still further, these fluctuations do not necessarily run parallel with those of the fertilizer cost. However, one may readily compute for himself the relative economy of producing these crop increases by applying any set of prices for crops and fertilizers which appear to be most applicable according to prevailing market conditions. For this purpose the following set of prices are assumed as representing the average market conditions for the past 6 years (December 1 quotations): wheat, $1.20 a bushel; corn, 68 cents; oats, 40 cents; and hay, $14 a ton. For the cost of the two phosphorus carriers, an estimate of $12 a ton for rock phosphate and $24 a ton for acid phosphate may be taken, thus making the expense for the two kinds of phosphate equal.

When these prices are applied to the yields given in Table 11, the acid phosphate plot with limestone shows the highest average annual gross return, $46.60. The limestone, however, appears to be responsible for only 54 cents of this amount, thus indicating that the purchase of limestone for this combination was unprofitable. The returns from rock phosphate with limestone were $1.69 an acre less than those from rock phosphate alone. Thus, of the treatments included in this test, the most profitable lies in one of the two forms of phosphates used alone, and the results thus far show a gross return of 65 cents per acre in favor of the acid phosphate. It is of interest to note that wheat has been the crop most affected by the form of phosphate applied. It is to be borne in mind that the order of values can easily be shifted by a change in the relative yields of the respective crops or by a change in commodity prices. Furthermore no consideration has been given here to any possible difference in the residual effects of the two forms of phosphate which might appear upon discontinuing the treatments.

THE ALEDO FIELD

An experiment field representing the soil type Brown Silt Loam On Clay is located in Mercer county just west of Aledo. This field has been in operation since 1910. From its physical aspects this field should be well adapted to experimental work, the land being unusually uniform in topography and in soil profile.

There are two general systems of plots and they are designated as the major and the minor systems. The major system comprizes four series (numbered 100, 200, 300, 400) made up of 10 plots each. The plots were handled substantially as described for standard treatment until 1918, when it was planned to harvest the first crop of red clover on the residues plots for hay and to plow down the second crop if no seed were formed. In 1921 the return of the oat straw was discontinued. In 1923 the rotation was changed to one of corn, corn, oats, and wheat. In this rotation it was planned to seed hubam clover in the oats on all plots, for use as hay or for soil improvement, and common sweet clover in the wheat on the residues plots for use as a green manure. Since this change, no residues except cornstalks and the green manure have been returned to the residues plots. The limestone applications were temporarily abandoned in 1923. No more will be applied until a need for lime appears. The phosphate applications were evened up to a total of 4 tons an acre in 1924, and no more will be applied for some time at least.

Table 12 gives a summary of the results, showing the average annual yields obtained for the period beginning when complete soil treatment came into sway. The lower section of the table, which gives comparisons in terms of crop increases, is intended to indicate the effect of the different fertilizing materials applied.

TABLE 12.—ALEDO FIELD: GENERAL SUMMARY OF CROP YIELDS
Average Annual Crop Yields 1912-1926—Bushels or (tons) per acre

Serial plot No.	Soil treatment	Wheat *12 crops*	Corn *19 crops*	Oats *14 crops*	Clover[1] *6 crops*	Soybeans *3 crops*
1	0	30.1	57.2	57.9	(2.21)	(1.60)
2	M	34.5	71.1	64.5	(2.74)	(1.63)
3	ML	34.6	74.3	67.6	(3.12)	(1.60)
4	MLP	36.6	75.6	68.2	(3.05)	(1.61)
5	0	30.8	60.1	59.7	(2.00)	16.1
6	R	31.4	66.5	61.2	(1.91)	16.5
7	RL	33.5	71.9	66.5	(1.96)	18.8
8	RLP	38.0	74.4	68.0	(2.08)	20.3
9	RLPK	37.3	76.0	70.3	(1.73)	20.9
10	0	30.1	58.3	58.1	(2.38)	(1.62)
	Crop Increases					
	M over 0	4.4	13.9	6.6	(.53)	(.03)
	R over 0	.6	6.4	1.5	–(.09)	.4
	ML over M	.1	3.2	3.1	(.38)	–(.03)
	RL over R	2.1	5.4	5.3	(.05)	2.3
	MLP over ML	2.0	1.3	.6	–(.07)	(.01)
	RLP over RL	4.5	2.5	1.5	(.12)	1.5
	RLPK over RLP	– .7	1.6	2.3	–(.35)	.6

[1]Some clover seed is evaluated as hay.

In looking over these results we may observe first the beneficial effect of animal manure (M) on all crops but especially on corn. This suggests the advisability of carefully conserving and regularly applying all stable manure. Residues (R) alone have been beneficial for corn but have shown little effect on the other crops of the rotation.

Where limestone (L) has been applied, there is usually a small increase in average yields, the increase becoming particularly marked in the corn crop in the residues system.

The addition of rock phosphate (P) to the treatment has had very little effect in the manure system. Somewhat more favorable are the results in the residues system, so that under average market conditions there has been some margin of profit from the use of rock phosphate applied in the manner of these experiments. However, the economic story has not all been told, for the application of lime and phosphate has been discontinued in order to observe the residual effects. The results of the next few years therefore, will be awaited with great interest.

For the effect of potassium treatment (K), we may compare Plots 8 and 9. No significant response appears from this treatment so far as these common field crops show.

A number of problems have arisen out of the experience on this and other experiment fields which call for some revision of the investigations described above, and accordingly certain changes have been made in the conduct of these plots which are intended especially to throw more light upon the problems of liming and applying phosphorus. (See Soil Report No. 29, Mercer County Soils).

Experiments on the Minor Series

The so-called minor system of plots (Series 500, 600, 700, 800) on the Aledo field is given over to a comparison of the effectiveness of different carriers of phosphorus.

In this experiment each series contains four plots. Plot 1 receives residues treatment only; Plot 2 receives residues and phosphorus in one of the forms under test; Plot 3 receives residues, limestone, and phosphorus; and Plot 4 is similar to Plot 3 with phosphorus omitted. On one series steamed bone meal (bP) is used as the carrier of phosphorus and is applied at the rate of 200 pounds per acre per year. On another series acid phosphate (aP) is applied at the yearly rate of 333⅓ pounds per acre. On a third series rock phosphate (rP) serves as the source of phosphorus and is applied at the rate of 666⅔ pounds per acre yearly. On the last series basic slag phosphate (sP) is applied at the rate of 250 pounds per acre yearly.

The yields for all crops harvested on these plots are recorded in Table 13. Table 14, which is derived from Table 13, shows differences in crop yields presumed to have resulted from applying the various forms of phosphatic fertilizers for the eleven crops harvested since the beginning of the applications up to 1926. In computing these comparisons, each phosphate plot is compared with its neighboring non-phosphate plot. Aside from the soybeans, the figures show without exception more or less crop increase on the phosphorus plots, no matter what the form of carrier employed.

TABLE 13.—ALEDO FIELD: PHOSPHATE EXPERIMENT
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied[1]	1916[2] Corn	1917[2] Oats	1918[2] Soybeans	1919 Wheat	1920 Corn	1921 Oats	1922 Clover hay	1923 Corn	1924 Corn	1925 Oats	1926 Wheat
501	R	53.4	85.5	18.9	32.4	72.8	48.9	(2.88)	83.5	58.2	63.9	44.0
502	RbP	61.7	91.7	19.0	34.7	86.4	61.9	(3.25)	82.7	66.0	75.0	59.2
503	RLbP	61.5	90.6	23.2	35.6	87.3	53.3	(3.48)	82.5	66.8	73.4	62.0
504	RL	55.1	80.5	22.6	32.9	77.7	47.7	(2.61)	88.2	60.3	64.5	44.6
601	R	55.2	84.7	19.5	33.0	71.2	53.6	(3.17)	84.7	57.3	64.4	43.3
602	RaP	57.8	87.7	18.7	38.3	87.1	60.9	(3.23)	82.5	65.9	76.1	60.6
603	RLaP	64.7	83.4	23.1	38.2	88.1	52.3	(3.53)	77.6	64.7	78.1	64.4
604	RL	51.9	81.7	24.6	32.8	84.9	50.2	(3.06)	84.1	51.9	64.1	47.3
701	R	54.3	83.1	20.8	34.2	75.6	52.8	(3.41)	82.8	61.2	66.6	44.8
702	RrP	58.8	83.3	23.3	36.7	80.4	63.0	(3.60)	87.8	69.3	70.3	59.2
703	RLrP	57.2	81.2	28.1	36.7	80.2	53.3	(3.82)	86.6	70.8	67.8	57.5
704	RL	52.1	81.7	26.9	34.1	82.0	48.9	(3.15)	84.6	62.5	66.3	48.8
801	R	57.6	73.8	18.0	33.7	68.1	54.8	(2.62)	74.3	58.8	45.0	45.8
802	RsP	56.4	87.8	20.6	38.1	81.0	66.2	(3.66)	80.0	69.1	66.3	60.2
803	RLsP	53.3	78.9	23.7	38.4	83.6	57.0	(3.63)	82.0	70.2	66.7	66.0
804	RL	51.8	77.5	21.8	33.3	70.4	59.8	(2.99)	82.6	59.9	53.9	48.2

[1]Bone meal (bP) at the rate of 200 pounds per acre per year. Acid phosphate (aP) at the rate of 333⅓ pounds per acre per year. Rock phosphate (rP) at the rate of 666⅔ pounds per acre per year. Slag phophate (sP) at the rate of 250 pounds per acre per year. All minerals applied once in the rotation ahead of the wheat crop.
[2]No residues.

Attention has already been called to the difficulties in making exact comparisons of this nature, on account of the fluctuation in prices of both farm products and fertilizer materials. A set of arbitrary prices, as indicated in the

TABLE 14.—ALEDO FIELD: AVERAGE ANNUAL CROP INCREASES PER ACRE AND THEIR VALUE PRODUCED BY THE VARIOUS FORMS OF PHOSPHATE
Computed from Yields in Table 13—Bushels or (tons) per acre

Comparison of treatments	Wheat *2 crops*	Corn *4 crops*	Oats *3 crops*	Clover *1 crop*	Soybeans *1 crop*	Value of increase *11 crops*[1]	Cost of phosphate *11 years*[2]	Profit from *11 crops*	Profit per acre per year
Bone meal, residues, *over* residues	8.8	7.2	10.1	(.37)	.1	$62.93	$44.00	$18.93	$1.72
Bone meal, residues, lime, *over*, residues, lime	11.0	4.2	8.2	(.87)	.6	65.12	44.00	21.12	1.92
Acid phosphate, residues *over* residues	11.3	6.2	7.3	(.06)	− .8	56.41	44.00	12.41	1.13
Acid phosphate, residues, lime, *over* residues, lime	11.3	5.6	6.0	(.47)	−1.5	57.95	44.00	13.95	1.27
Rock phosphate, residues, *over* residues	8.5	5.6	4.7	(.19)	2.5	51.00	44.00	7.00	.64
Rock phosphate, residues, lime, *over* residues, lime	5.7	3.4	1.8	(.67)	1.2	38.73	44.00	−5.27	− .48
Slag phosphate, residues, *over* residues	9.3	6.9	15.4	(1.04)	2.6	84.24	27.50	56.74	5.16
Slag phosphate, residues, lime, *over* residues, lime	11.4	6.1	3.8	(.64)	1.9	64.38	27.50	36.88	3.35

[1]With wheat at $1.25 a bushel, corn at 75 cents, oats at 45 cents, soybeans at $1.50, and clover at $15 a ton; which values, with the exception of that for soybeans, are all under the average December 1 farm price quotations for the eleven years in which these crops were produced. No official quotations were found for soybeans.
[2]The cost of the phosphatic materials is estimated as follows: bone meal $40 a ton, acid phosphate $24, rock phosphate $12, and slag phosphate $20.

footnote to Table 14, may therefore be assumed as representing approximately average market conditions. The values for the phosphatic fertilizers would seem conservative enough, and furthermore the quantities of these materials employed in these experiments are, with the possible exception of the slag phosphate, greater than ordinarily would be used, or need to be used, in good farm practice.

Reckoned on the basis of the prices shown, slag phosphate appears to have produced the most profitable returns of the four phosphorus carriers in the test, bringing an average profit of $5.16 an acre yearly where applied without limestone and $3.35 where applied with limestone. Bone meal has given an average profit of $1.72 applied without limestone and $1.92 applied with limestone. Acid phosphate has returned $1.13 used without limestone and $1.27 used with limestone. Rock phosphate has produced the lowest money returns, giving a profit of 64 cents an acre a year when applied without limestone and a loss of 48 cents when used with limestone.

No consideration is given in these comparisons to the relative phosphorus reserves which should have accumulated in the soil, and it should be emphasized again that the order of these values might be easily shifted by relatively small change in commodity prices.

The results from the limestone treatments on the plots of this minor series are shown in Table 15. This material was applied to Plots 3 and 4 in 1912, when the land was still under alfalfa, at the rate of 4 tons an acre, and another dressing was added in 1917, after the present experiments were under way.

Comparing first the results from the check plots, which receive no phosphorus, it appears that limestone used with residues alone has been of doubtful benefit to all crops excepting soybeans.

TABLE 15.—ALEDO FIELD: AVERAGE ANNUAL CROP INCREASES PER ACRE AND THEIR VALUE PRODUCED BY LIMESTONE

Computed from Yields in Table 13—Bushels or (tons) per acre

Comparison of treatments	Wheat *2 crops*	Corn *4 crops*	Oats *3 crops*	Clover *1 crop*	Soybeans *1 crop*	Value of increase *11 crops*[1]	Cost of limestone *11 years*[2]	Profit from *11 crops*	Profit per acre per year
Limestone, residues, *over* residues	1.4	2.0	− .1	−(.07)	4.7	$15.36	$12.00	$3.36	$ .31
Limestone, residues, bone meal, *over* residues, bone meal	2.8	.3	−3.8	(.23)	4.2	12.52	12.00	.52	.05
Limestone, residues, acid phosphate, *over* residues, acid phosphate	1.9	.5	−3.6	(.30)	4.4	12.49	12.00	.49	.04
Limestone, residues, rock phosphate, *over* residues, rock phosphate	− .9	− .4	−4.8	(.22)	4.8	.57	12.00	−11.43	−1.04
Limestone, residues, slag phosphate, *over* residues, slag phosphate	3.1	.7	−5.8	−(.03)	3.1	6.22	12.00	− 5.78	− .53

[1]For crop values used in these computations, see footnotes to Table 14.
[2]A charge of $2 a ton is made for the six tons of limestone applied.

Considering all treatments, the soybeans exhibit a consistent gain from limestone, while oats respond with a consistent loss. At the prices for crops and limestone assumed in these computations, a profit of 31 cents an acre a year for limestone applied without phosphate of any kind is found. Where limestone was applied with bonemeal, the limestone profit was 5 cents an acre a year, and with acid phosphate it was 4 cents. Used with rock phosphate, the crop increases were so small that there was a loss of $1.04 an acre a year.

When the small margin of profit and the possible experimental error involved in this kind of work are considered, it is doubtful whether limestone used with phosphates in the manner described has, up to the present time, paid its cost. The Aledo field represents one of those borderline cases, so to speak, in which the upper soil is neutral or only slightly acid and the lime requirement, therefore, not yet very marked. As time goes on, however, and cropping continues, the need for lime will develop. It is planned to discontinue liming on these plots until its need becomes manifest, and in so doing the annual cost of the limestone already applied will become automatically reduced, so that net returns which hitherto have represented a loss may sooner or later result in a positive profit.

THE HARTSBURG FIELD

Black Clay Loam, Terrace, as noted on page 21, occupies 15 square miles in Henry county. The results of the Hartsburg field, situated in Logan county just east of the town of Hartsburg, are suggestive of the treatments that are effective on this type of soil.

TABLE 16.—HARTSBURG FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields 1913-1926—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Wheat *12 crops*	Corn *19 crops*	Oats *14 crops*	Clover[2] *7 crops*	Soybeans *2 crops*	Alfalfa[1] *11 crops*
1	0	25.6	46.5	46.7	(1.84)	(1.29)	(3.47)
2	M	29.9	57.0	52.6	(2.19)	(1.64)	(3.67)
3	ML	35.0	62.9	58.0	(2.32)	(1.82)	(3.91)
4	MLP	37.2	61.8	57.5	(2.39)	(1.92)	(4.19)
5	0	30.5	52.1	46.0	(1.28)	25.8	(3.33)
6	R	33.6	62.3	54.1	(1.67)	26.8	(3.78)
7	RL	31.0	66.3	52.2	(1.64)	28.4	(3.45)
8	RLP	35.2	65.4	56.3	(1.79)	26.1	(4.04)
9	RLPK	34.6	64.3	55.4	(2.13)	26.4	(4.16)
10	0	31.1	51.6	47.4	(2.02)	(1.69)	(3.20)
	Crop Increases						
	M over 0	4.3	10.5	5.9	(.35)	(.35)	(.20)
	R over 0	3.1	10.2	8.1	(.39)	1.0	(.45)
	ML over M	5.1	5.9	5.4	(.13)	(.18)	(.24)
	RL over R	−2.6	4.0	−1.9	−(.03)	1.6	−(.33)
	MLP over ML	2.2	−1.1	− .5	(.07)	(.10)	(.28)
	RLP over RL	4.2	− .9	4.1	(.15)	− 2.3	(.59)
	RLPK over RLP	− .6	−1.1	− .9	(.34)	.3	(.12)

[1]No residues for the first six crops. [2]Some clover seed is evaluated as hay.

This field was started in 1911 and laid off in five series of 10 plots each. The crop rotation up to 1923 was wheat, corn, oats, and clover, with alfalfa growing on a fifth series. The program was then changed to corn, corn, oats, and wheat with sweet clover catch crop on the first series, and corn, oats, wheat, and legume hay (clover and alfalfa mixture) on the fifth series. The soil treatments are as indicated in Table 16, which summarizes by crops the yields for the period during which the plots have been under full treatment.

The outstanding feature of the results on this field is the large increases produced by organic manures whether in the form of crop residues or stable manure. The behavior of limestone (L) is rather peculiar in that it has been more beneficial where applied with manure than where used with residues. Used with manure it shows some increase in all crops, while with residues its effect on several of the crops appears negative.

Altho rock phosphate (P) has given some increases in wheat yield in both the manure and the residues systems, the results with other crops have been such as to render the use of this material unprofitable on this field. The addition of potassium (K) appears to have produced no significant effect.

It may be mentioned that new experiments have been recently started on these plots which are designed to answer some of the questions brought out by the foregoing results. For example, the effect of applying phosphorus in other carriers and in different combinations, as well as testing the residual effect of phosphate already applied, is being tried.

THE VIENNA FIELD

Henry county, as indicated in the descriptions of certain of its soil types, includes considerable land that is subject to destruction thru erosion or washing. Yellow Silt Loam, which occupies over 38 square miles in the county, is par-

FIG. 12.—PROPER SOIL AND CROPPING METHODS WOULD HAVE PREVENTED THIS CONDITION

This abandoned hillside is just over the fence from the field shown in Fig. 13. Yellow Silt Loam is particularly susceptible to this kind of damage.

ticularly susceptible to this kind of damage. Operators of this kind of land in Henry county will therefore be interested in experiments conducted on the Vienna field, in Johnson county, to test out different methods of reclaiming badly gullied land and preventing further erosion.

The Vienna field is representative of the sloping, erodible land so common in the extreme southern part of the state. When the experiments were started the whole field, with the exception of about three acres, had been abandoned because so much of the surface soil had washed away, and there were so many gullies that further cultivation was unprofitable. For the purpose of the experiments the field was divided into different sections (see Table 17). These were not entirely uniform; some parts were much more washed than others, and portions of the lower-lying land had been affected by soil material washed down from above. The higher land had a very low producing capacity; on many spots little or nothing would grow.

Limestone was applied to the entire field at the rate of 2 tons an acre. Corn, cowpeas, wheat, and clover were grown in a four-year rotation on each section except the one designated as D, which included but three plots.

Careful records were kept for nine years. The results, summarized in Table 17 indicate something of the possibilities in improving hillside land by protecting it from erosion. The average yield of corn from the protected series (A, B, and C) was 30.6 bushels an acre, as against 14.1 bushels on the check series (D). Wheat yielded 11.1 bushels on the protected series, in comparison with 4.6 bushels on the check, and clover yielded 4/5 of a ton on the protected series and but 1/5 of a ton on the check.

Figs. 12 and 13 serve further to indicate what may be done with this type of soil even after it has become badly washed and gullied.

FIG. 13.—CORN GROWING ON AN IMPROVED HILLSIDE OF THE VIENNA EXPERIMENT FIELD

This land had formerly been badly eroded. It was reclaimed by proper soil treatment and cropping. Compare with Fig. 12.

TABLE 17.—VIENNA FIELD: HANDLING HILLSIDE LAND TO PREVENT EROSION
Average Annual Yields 1907-1915—Bushels or (tons) per acre

Section	Method	Corn *7 crops*	Wheat *7 crops*	Clover *3 crops*
A	Terrace	31.4	9.0	(.68)
B	Embankments and hillside ditches	32.4	12.7	(.97)
C	Organic matter, deep contour plowing, and contour planting	27.9	11.7	(.80)
D	Check	14.1	4.6	(.21)

Section A included the steepest part of the field and contained many gullies. The land was built into terraces at vertical intervals of 5 feet. Near the edge of each terrace a small ditch was placed so that the water could be carried to a natural outlet without much washing.

Section B was used to test the so-called embankment method. Ridges were plowed up which were sufficiently high so that when there were heavy falls of rain the water would break over and run in a broad sheet rather than in narrow channels. At the steepest part of the slope, hillside ditches were made for carrying away the run-off.

Section C was washed badly but contained only small gullies. Here the attempt was made to prevent washing by incorporating organic matter in the soil and practicing deep contour plowing and contour planting. With two exceptions, about 8 loads of manure an acre were turned under each year for the corn crop.

Section D was washed to about the same extent as Section C. It was farmed in the most convenient way, without any special effort to prevent washing.

Manure
Yield: Nothing

Manure and limestone
Yield: 4.43 tons per acre

FIG. 14.—ALFALFA ON THE OQUAWKA FIELD

These pictures show the possibility of improving this unproductive sandy land of the Oquawka field. Both plots were seeded alike to alfalfa. Where manure alone was applied, the crop was a total failure, but where limestone in addition to manure was applied, nearly 4½ tons of alfalfa hay was obtained as the season's yield.

THE OQUAWKA FIELD

Since there are considerable areas of Dune Sand, Terrace, in Henry county, experiments on that type conducted by the University in Henderson county, near the Mississippi river, will be of interest. The Oquawka field was established in 1913. It is divided into six series of plots. Corn, soybeans, wheat, sweet clover, and rye, with a catch crop of sweet clover seeded in the rye on the residues plots, are grown in rotation on five series, while the sixth series is devoted to alfalfa. When sweet clover seeded in the wheat fails, cowpeas are substituted. Table 18 indicates the kinds of treatment applied; the amounts of the materials used were in accord with the standard practice, as explained on page 46.

Limestone (L), it will be noted, has had a remarkably beneficial action on this sand soil. Where it has been used in conjunction with crop residues, the yield of corn has been practically doubled. It has also produced good crops of rye and fair crops of sweet clover and alfalfa.

This land appears to be quite indifferent to treatment with rock phosphate (P). The analyses show, however, that the stock of phosphorus in this type of soil is not large; and as time goes on and the supply diminishes under the production a good-sized crops, the application of this element may become

TABLE 18.—OQUAWKA FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields 1915-1926—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn *12 crops*	Soybeans[1] *12 crops*	Wheat *12 crops*	Sweet clover[2] *8 crops*	Rye *10 crops*	Alfalfa *9 crops*
1	0	20.2	(.99)	8.7	0.00	12.1	(.42)
2	M	25.3	(1.19)	12.0	0.00	13.7	(.92)
3	ML	33.4	(1.61)	16.1	1.03	24.7	(2.37)
4	MLP	33.9	(1.56)	16.4	1.05	23.4	(2.45)
5	0	19.7	(.77)	10.7	0.00	12.7	(.40)
6	R	21.2	(.82)	12.2	0.00	12.9	(.45)
7	RL	37.2	(1.17)	15.1	1.41	24.0	(2.11)
8	RLP	37.0	(1.25)	15.6	1.28	24.1	(2.10)
9	RLPK	39.2	(1.20)	14.9	1.49	26.0	(2.17)
10	0	18.6	(.71)	9.6	0.00	10.3	(.29)
	Crop Increases						
	M over 0	5.1	(.20)	3.3	0.00	1.6	(.50)
	R over 0	1.5	(.05)	1.5	0.00	.2	(.05)
	ML over M	8.1	(.42)	4.1	1.03	11.0	(1.45)
	RL over R	16.0	(.35)	2.9	1.41	11.1	(1.66)
	MLP over ML	.5	–(.05)	.3	.02	– 1.3	(.08)
	RLP over RL	– .2	(.08)	.5	– .13	.1	–(.01)
	RLPK over RLP	2.2	–(.05)	– .7	.21	1.9	(.07)

[1]Eleven regular crops, together with the extra crop described in footnote 2, are averaged as 11 crops. Several crops which were harvested as seed are evaluated in this summary as hay.

[2]Some hay is evaluated as seed. In 1918 the sweet clover was killed by early cutting for a hay crop; soybeans were seeded in July, and the ensuing crop is included in the soybean average.

profitable. It is also quite possible that a more available form of phosphate could be used to advantage on this very sandy soil.

Altho the results show an increase of about 2 bushels of corn from the use of potassium salts (K), with ordinary prices this would not be a profitable treatment. The slight increases from the use of potassium appearing in the other crops are scarcely significant.

A significant fact which the above summary does not bring out is that improvement in crop yields under favorable treatment has been progressive, as evidenced by a very marked upward trend in production after the first few years. The yield of corn, for example under the limestone-residues (RL) treatment has been 37.2 bushels an acre as an average for the 12 crops since full treatment started, but if we take an average of the last five crops, the yield rises to 42.9 bushels. Likewise the wheat yields under this same treatment for the eleven-year average is 15.1 bushels, but the average for the last five years is 22.3 bushels.

Experience thus far shows rye to be better adapted to this land than wheat, and both alfalfa and sweet clover do better than soybeans. With these two legume crops thriving so well under this simple treatment, we have promise of great possibilities for the profitable culture of this land, which hitherto has been considered as practically worthless.

THE MANITO FIELD

The Manito experiment field, in Mason county, which was in operation from 1902 to 1905, gives some interesting results of the effects of soil treatment on Deep Peat. There are altogether about 7½ square miles of Deep Peat in Henry county.

The field consisted of ten plots which received the treatments indicated in Table 19. Where potassium was applied, the yield was three to four times as large as where nothing was applied. Where approximately equal money values of kainit and potassium chlorid were used, slightly greater yields were obtained with the potassium chlorid, which, however, supplied about one-third more potassium than the kainit. However, either material furnished more potassium than was required by the crops produced.

TABLE 19.—MANITO FIELD: Deep Peat
Annual Crop Yields—Bushels per acre

Plot No.	Soil treatment 1902	Corn 1902	Corn 1903	Soil treatment 1904	Corn 1904	Corn 1905
1	None	10.9	8.1	None	17.0	12.0
2	None	10.4	10.4	Limestone, 4000 lbs.	12.0	10.1
3	Kainit, 600 lbs.	30.4	32.4	Limestone, 4000 lbs., kainit, 1200 lbs.	49.6	47.3
4	Kainit, 600 lbs., acidulated bone, 350 lbs.	30.3	33.3	Kainit, 1200 lbs., steamed bone, 395 lbs.	53.5	47.6
5	Potassium chlorid, 200 lbs.	31.2	33.9	Potassium chlorid, 400 lbs.	48.5	52.7
6	Sodium chlorid, 700 lbs.	11.1	13.1	None	24.0	22.1
7	Sodium chlorid, 700 lbs.	13.3	14.5	Kainit, 1200 lbs.	44.5	47.3
8	Kainit, 600 lbs.	36.8	37.7	Kainit, 600 lbs.	44.0	46.0
9	Kainit, 300 lbs.	26.4	25.1	Kainit, 300 lbs.	41.5	32.9
10	None	(1)	14.9	None	26.0	13.6

[1]Yield not recorded for 1902.

The use of 700 pounds of sodium chlorid (common salt) yielded no great increase over the best untreated plots, indicating that where potassium is itself actually deficient, salts of other elements cannot take its place.

Applications of 2 tons of ground limestone per acre produced no increase in the corn crops either when applied alone or in combination with kainit, either the first year or the second.

Reducing the application of kainit from 600 to 300 pounds for each two-year period reduced the total yield of corn from 164.5 to 125.9 bushels. The two applications of 300 pounds of kainit (Plot 9) appear to be insufficient.

List of Soil Reports Published

1 Clay, 1911
2 Moultrie, 1911
3 Hardin, 1912
4 Sangamon, 1912
5 LaSalle, 1913
6 Knox, 1913
7 McDonough, 1913
8 Bond, 1913
9 Lake, 1915
10 McLean, 1915
11 Pike, 1915
12 Winnebago, 1916
13 Kankakee, 1916
14 Tazewell, 1916
15 Edgar, 1917
16 DuPage, 1917
17 Kane, 1917
18 Champaign, 1918
19 Peoria, 1921
20 Bureau, 1921
21 McHenry, 1921
22 Iroquois, 1922
23 DeKalb, 1922
24 Adams, 1922
25 Livingston, 1923
26 Grundy, 1924
27 Hancock, 1924
28 Mason, 1924
29 Mercer, 1925
30 Johnson, 1925
31 Rock Island, 1925
32 Randolph, 1925
33 Saline, 1926
34 Marion, 1926
35 Will, 1926
36 Woodford, 1927
37 Lee, 1927
38 Ogle, 1927
39 Logan, 1927
40 Whiteside, 1928
41 Henry, 1928

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(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

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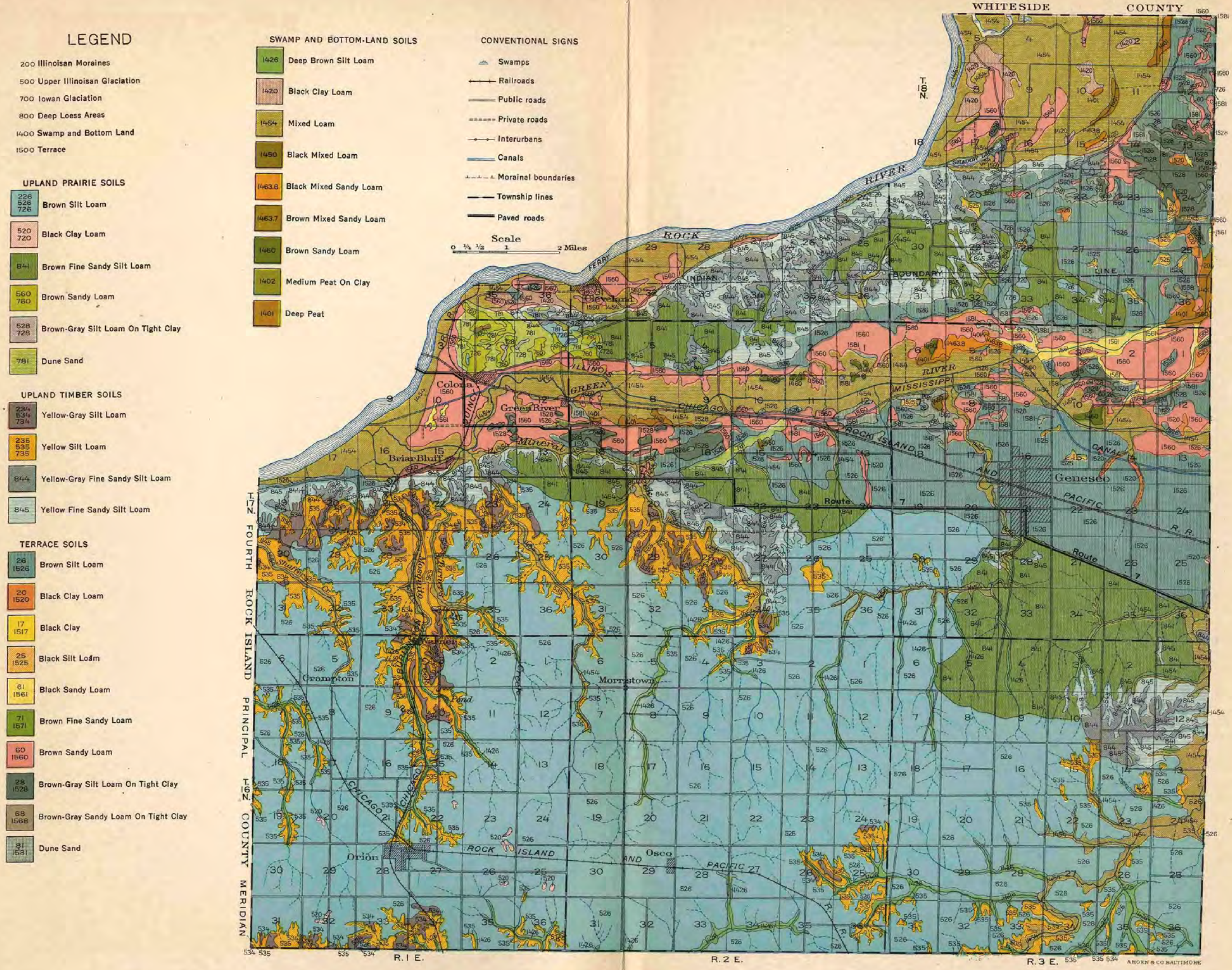
NORTHWEST SHEET



SOIL SURVEY MAP OF HENRY COUNTY
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

NORTHEAST SHEET

LEGEND

200 Illinoisan Moraines
500 Upper Illinoisan Glaciation
700 Iowan Glaciation
800 Deep Loess Areas
1400 Swamp and Bottom Land
1500 Terrace

UPLAND PRAIRIE SOILS

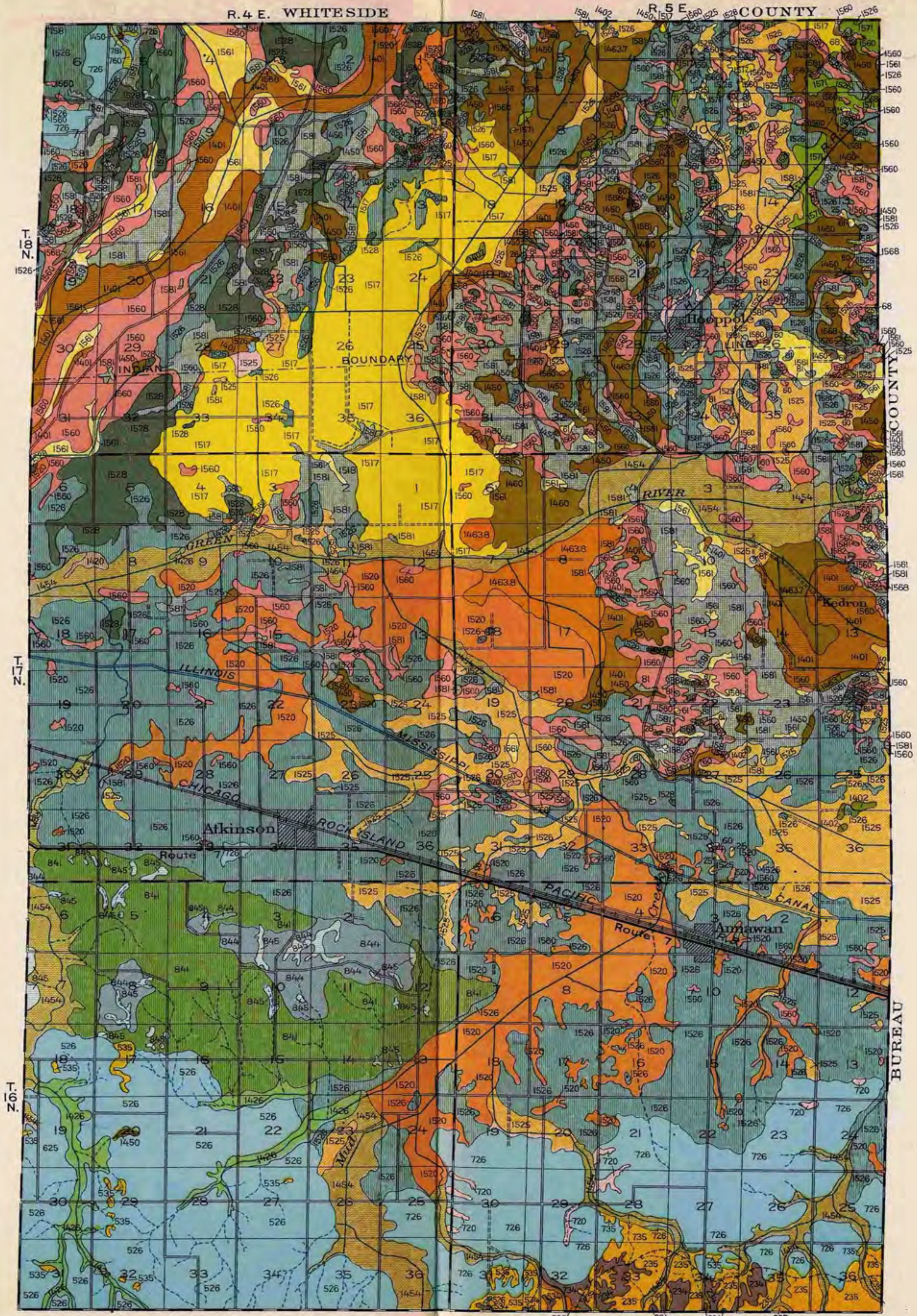
- 226 526 726 — Brown Silt Loam
- 520 720 — Black Clay Loam
- 841 — Brown Fine Sandy Silt Loam
- 560 760 — Brown Sandy Loam
- 528 728 — Brown-Gray Silt Loam On Tight Clay
- 781 — Dune Sand

UPLAND TIMBER SOILS

- 234 534 734 — Yellow-Gray Silt Loam
- 235 535 735 — Yellow Silt Loam
- 844 — Yellow-Gray Fine Sandy Silt Loam
- 845 — Yellow Fine Sandy Silt Loam

TERRACE SOILS

- 26 1526 — Brown Silt Loam
- 20 1520 — Black Clay Loam
- 17 1517 — Black Clay
- 25 1525 — Black Silt Loam
- 61 1561 — Black Sandy Loam
- 71 1571 — Brown Fine Sandy Loam
- 60 1560 — Brown Sandy Loam
- 28 1528 — Brown-Gray Silt Loam On Tight Clay
- 68 1568 — Brown-Gray Sandy Loam On Tight Clay
- 81 1581 — Dune Sand



SWAMP AND BOTTOM-LAND SOILS

- 1426 — Deep Brown Silt Loam
- 1420 — Black Clay Loam
- 1454 — Mixed Loam
- 1450 — Black Mixed Loam
- 1463.8 — Black Mixed Sandy Loam
- 1463.7 — Brown Mixed Sandy Loam
- 1480 — Brown Sandy Loam
- 1402 — Medium Peat On Clay
- 1401 — Deep Peat

CONVENTIONAL SIGNS

- Swamps
- Railroads
- Public roads
- Private roads
- Interurbans
- Canals
- Morainal boundaries
- Township lines
- Paved roads

Scale
0 ¼ ½ 1 2 Miles

SOIL SURVEY MAP OF HENRY COUNTY

UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

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- 520, 720 — Black Clay Loam
- 841 — Brown Fine Sandy Silt Loam
- 560, 760 — Brown Sandy Loam
- 528, 728 — Brown-Gray Silt Loam On Tight Clay
- 781 — Dune Sand

UPLAND TIMBER SOILS

- 234, 534, 734 — Yellow-Gray Silt Loam
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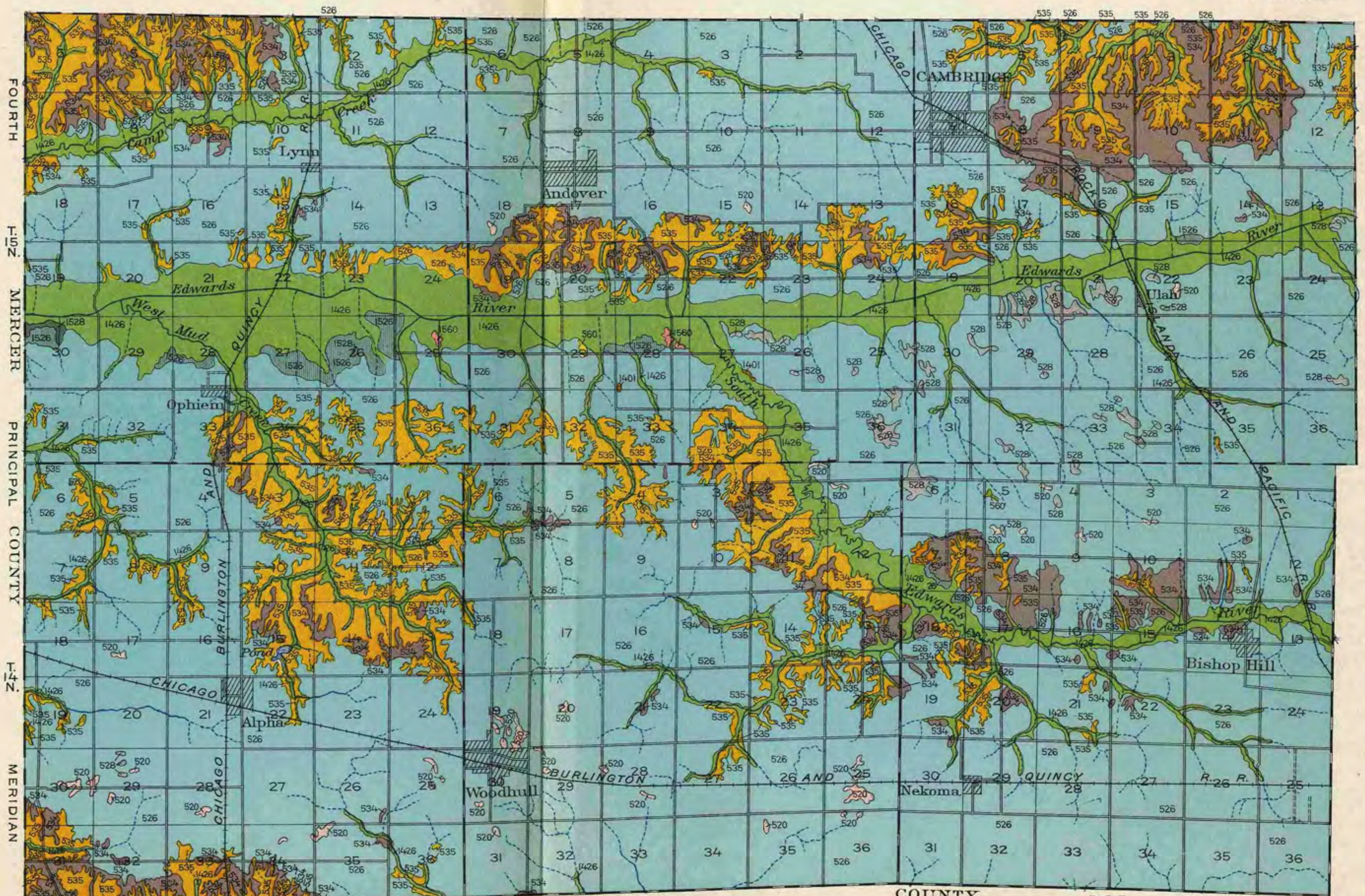

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520 720	Black Clay Loam
841	Brown Fine Sandy Silt Loam
560 760	Brown Sandy Loam
528 728	Brown-Gray Silt Loam On Tight Clay
781	Dune Sand

UPLAND TIMBER SOILS

234 534 734	Yellow-Gray Silt Loam
235 535 735	Yellow Silt Loam
844	Yellow-Gray Fine Sandy Silt Loam
845	Yellow Fine Sandy Silt Loam

TERRACE SOILS

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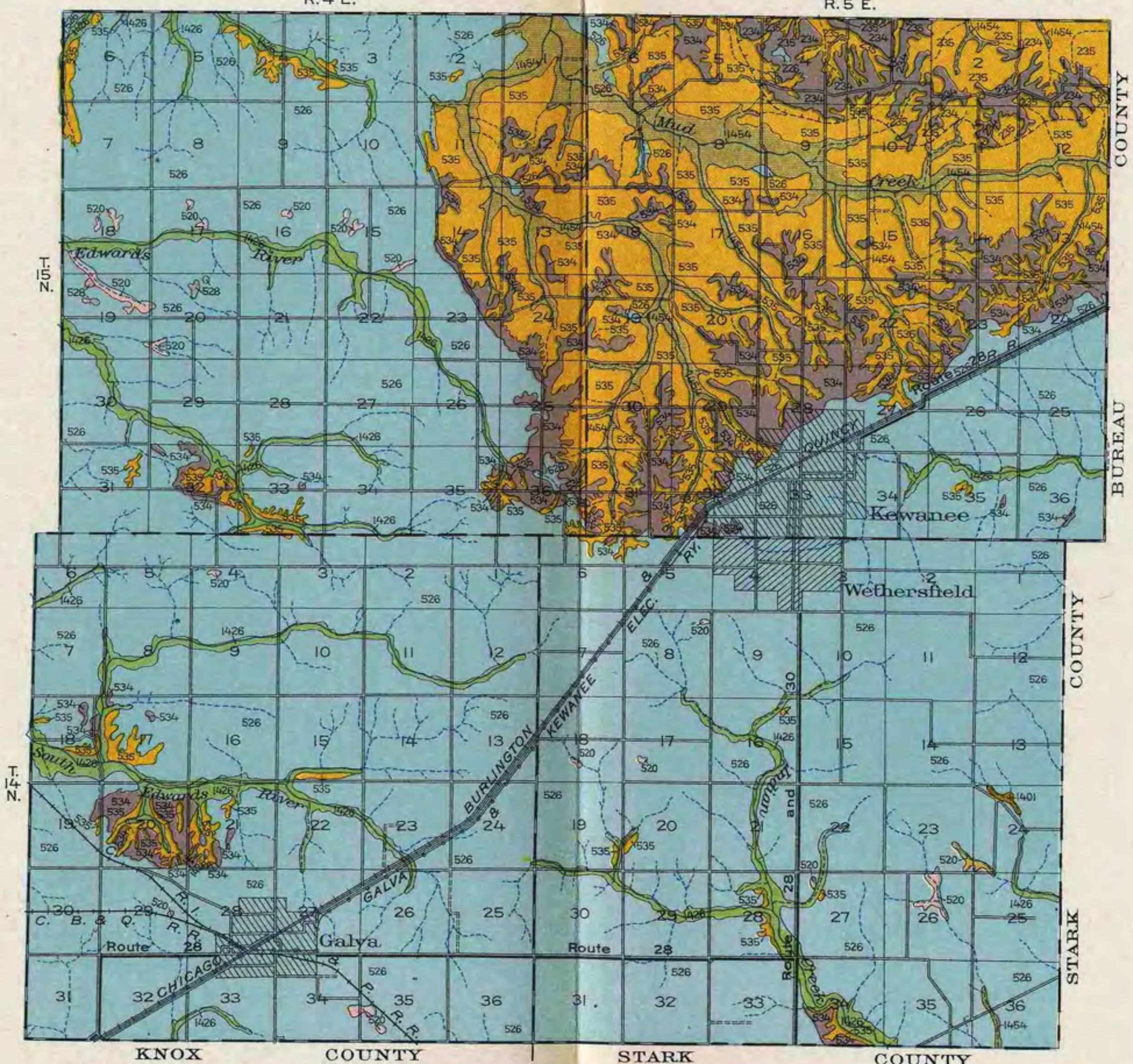

SWAMP AND BOTTOM-LAND SOILS

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1460	Brown Sandy Loam
1402	Medium Peat On Clay
1401	Deep Peat

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0 ¼ ½ 1 2 Miles

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